JULY-AUGUST 1961

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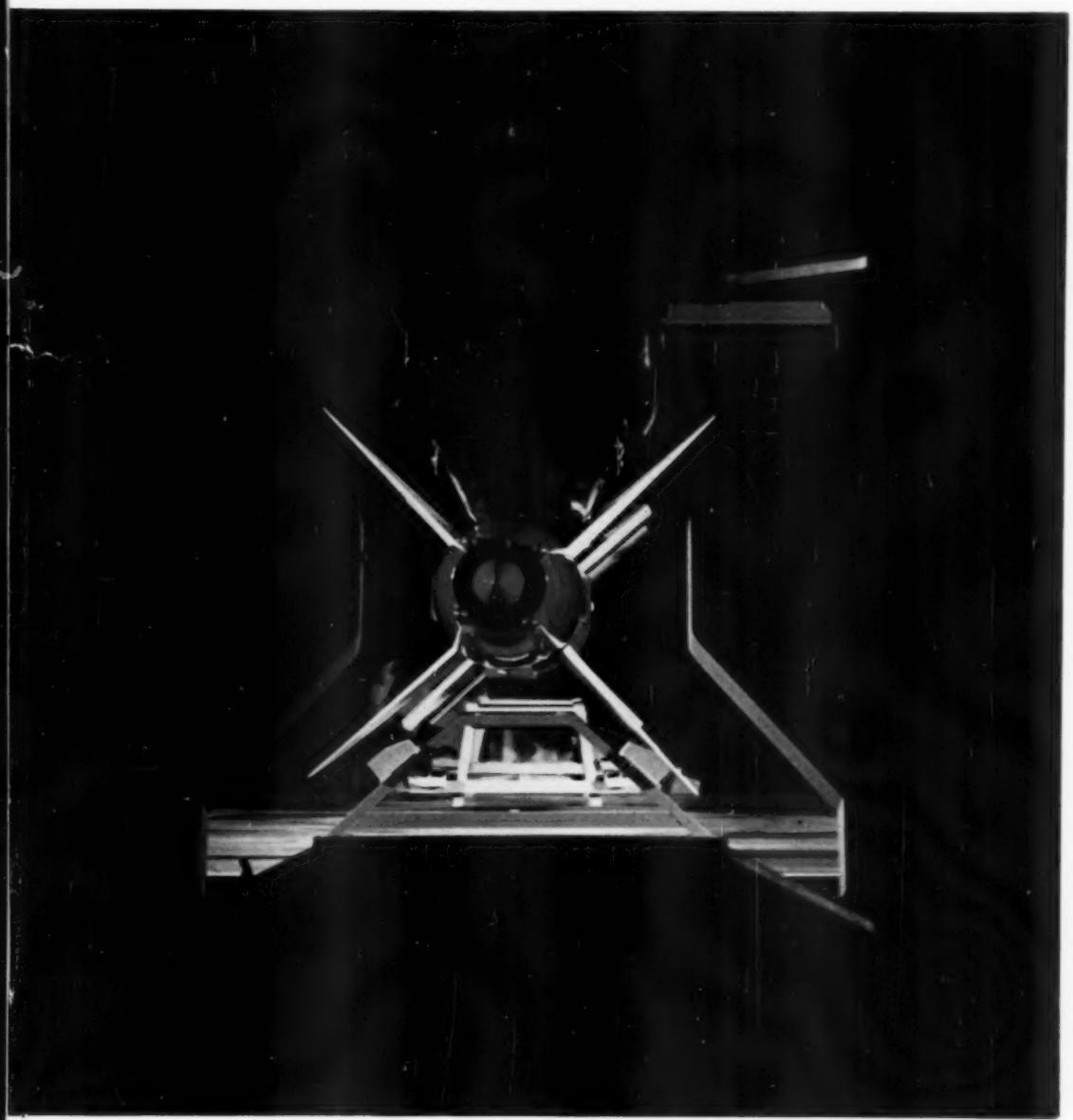

Talos prepares for action

In this issue: Vice Adm. C. L. Melson • Brig. Gen. S. R. Shaw • Rear Adm. P. D. Stroop
Rear Adm. H. L. Miller • George Fielding Eliot • Vern Haugland • Garrett Underhill

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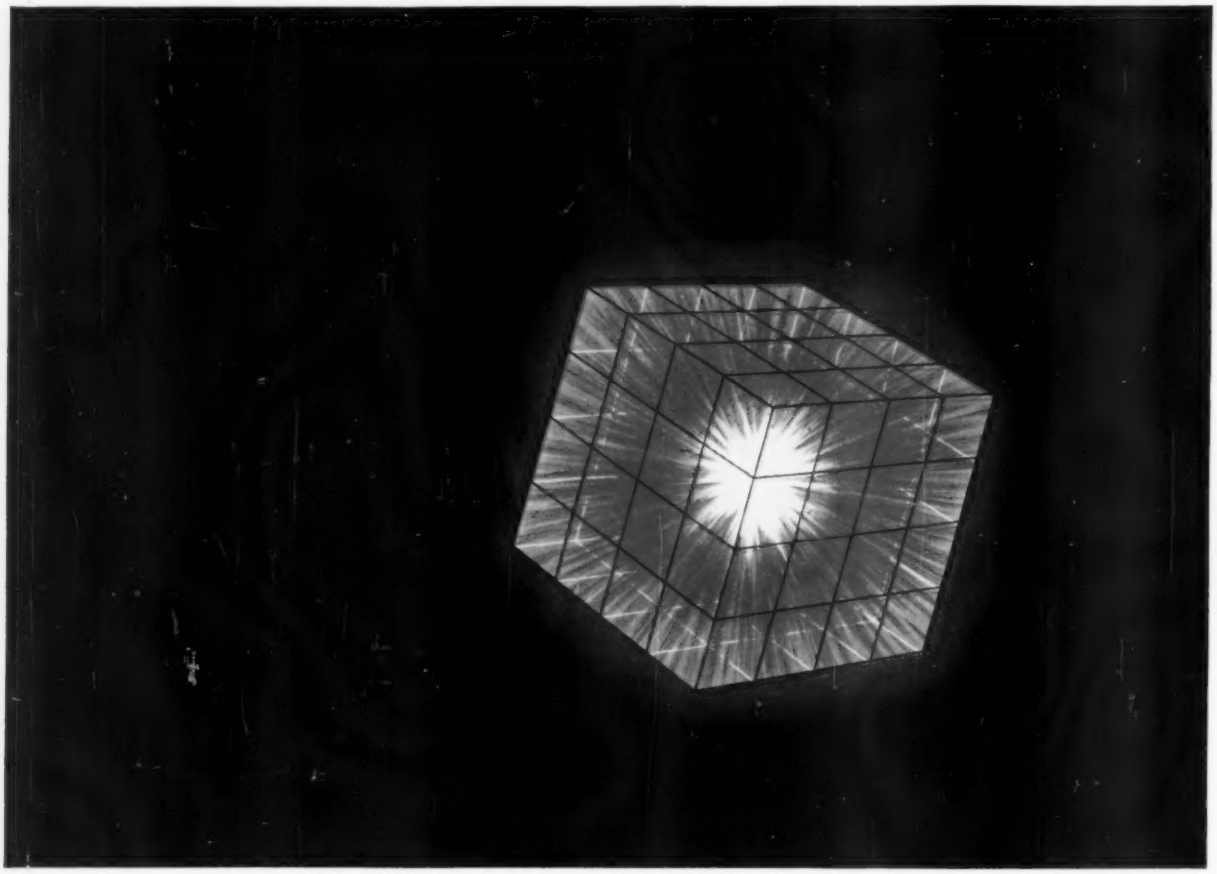

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VOL. XLVI JULY-AUGUST NO. 247

The Cover.—This striking photograph depicts the Navy's Talos surface-to-air missile emerging from the shipboard Mk. 12 guided-missile launching system for transfer to the on-deck launcher. Blast doors are partially open, and the missile is headed toward the camera from the checkout area.

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IN THIS ISSUE

(see synopses overleaf)

The Service Secretaries		35
Sea Power in the Pacific	Vice Adm. C. L. Melson	36
The Amphibious Assault	Brig. Gen. S. R. Shaw	39
Weapons for the Fleet	Rear Adm. Paul D. Stroop	42
Proving Ground of Policy	Maj. George Fielding Eliot	45
Destroy That Satellite!	Vern Haugland	49
The New Warfare	Garrett Underhill	54
Intelligence Is the Key	Harold Tombach	59
Arms for the Men	F. W. Foster Gleason	62
Defense Highlights		67
Weapons for Limited War	An Editorial	69

IN EVERY ISSUE

Atomic Energy	27	Materials Progress	116
Association Affairs	70	Rockets & Guided Missiles	120
New Developments	97	Armament Electronics	126
Space Armament	104	From the Record	128
Underwater Ordnance	108	Book Reviews	134
Missile Support Equipment	112	Index of Advertisements	159

ARMAMENT TECHNOLOGY

Minuteman Vehicle Design	D. L. Baker	141
Take-off, Vertical!	Loren E. Bollinger	144
New Antitank Weapon	Robert E. Sebring	147
Solid-Propellant Rockets	J. L. McDaniel	150
Antisubmarine Warfare	Rear Adm. H. L. Miller	153

ON THE

THE CONTENTS OF THIS ISSUE IN BRIEF

In the present world situation the ability to use the sea lanes is vital to the United States and its allies. Vice Adm. C. L. Melson here tells how the First and Seventh Fleets with their balanced forces of ships and men are safeguarding the rights of the independent nations in the Pacific area.

This and the following two articles are based on addresses delivered at the Forty-third Annual Meeting of the American Ordnance Association, Los Angeles, Calif., May 16, 1961.

Putting the Marines on the beach under enemy fire is a vast and complex operation that demands the teamwork of all the armed forces. Also required, says Brig. Gen. S. R. Shaw, U.S.M.C., are specialized weapons and techniques to meet the needs of today's fast-moving combat.

The "Kiss Program" is doing wonders in reducing the costs of our expensive naval weapons. "Kiss" stands for "Keep it simple, stupid!" and the program is helping hold down engineering changes, especially in production models, according to Rear Adm. Paul D. Stroop, Chief of the Bureau of Naval Weapons. He also reports that cooperation among the armed services in weapons development is not only good but outstanding.

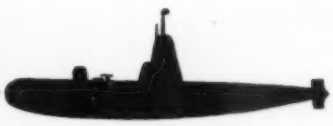
"Decisions which contain too great an element of computer-produced 'analysis' to the neglect of the intensely human factors which are woven into the warp and woof of military judgment can prove fatally defective when put to the test of conflict—where man, and not the machine is still the ruling element." So says George Fielding Eliot, noted military writer, who believes that national strategy should never be finalized without close collaboration between civilian authority and military advisers.

Antisatellite satellites are among the latest defense weapons now under research. With the advent of space vehicles that can reconnoiter and perhaps loose lethal weapons at ground targets, it is necessary for us to be prepared to defend against them, writes Vern Haugland, aviation authority.

A technological revolution is now under way, and the world struggle is not so much on the battlefields as in the laboratories and on the proving grounds. Garrett Underhill, noted military analyst, here shows that, while the U. S. must increase its spending for weapons research, many of these developments eventually will find peacetime civilian uses.

In this atomic age when nuclear weapons could wipe out an unprepared nation in a matter of minutes, it is of the great-

TARGET



est importance that we know the military preparations and capabilities of any potential enemy so that we can be ready to defend against attack and perhaps thus even deter aggression. "Effective intelligence also can contribute to national prosperity," writes Harold Tombach.

The Civil War opened with a shortage of efficient small arms and artillery on both sides, and the gap was never really closed. The blockade continually hampered the South, while battle losses and official obstructionism hurt the North. Superior production facilities and the acquisition of breechloaders and repeating rifles eventually swung the tide in favor of the Union, as F. W. Foster Gleason here so graphically tells.

The Minuteman is a solid-propellant intercontinental ballistic missile with a mission to destroy strategic targets. Still in the research and development stage, it is rapidly becoming operational. D. L. Baker here points out the importance of the proper materials to missile range, cost, and reliability.

Loren Bollinger tells the exciting story of how the X-13 Vertijet raced against time to prove that an airplane could really take off and land straight up and down and also fly in the conventional horizontal attitude.

The David and Goliath story has come full circle with the development of the lightweight M72 system which enables one man to knock out a mighty armored vehicle with a rocket-launcher combination that weighs only 4.5 pounds. "This is another big step in reequipping our Army with a new generation of modern weapons," writes Robert E. Sebring.

Large missiles powered by a solid propellant can be deployed instantly from a highly mobile division or field army or they can be constantly ready for retaliatory action from a fixed base. J. L. McDaniel outlines the task of reducing the weight of all missile elements other than the final payload while at the same time obtaining the required simplicity, ruggedness, and reliability.

Our naval forces now have the ships, aircraft, weapons, and detection devices capable of finding and destroying hostile snorkel-equipped, diesel-powered submersibles, but much more of this equipment is needed. However, according to Rear Adm. H. L. Miller, the quiet-running nuclear-powered sub will present an entirely new problem that must be solved if our Nation is to survive.

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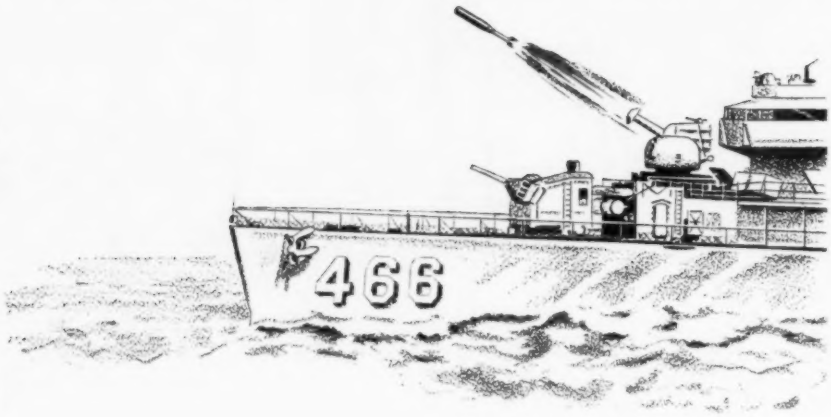

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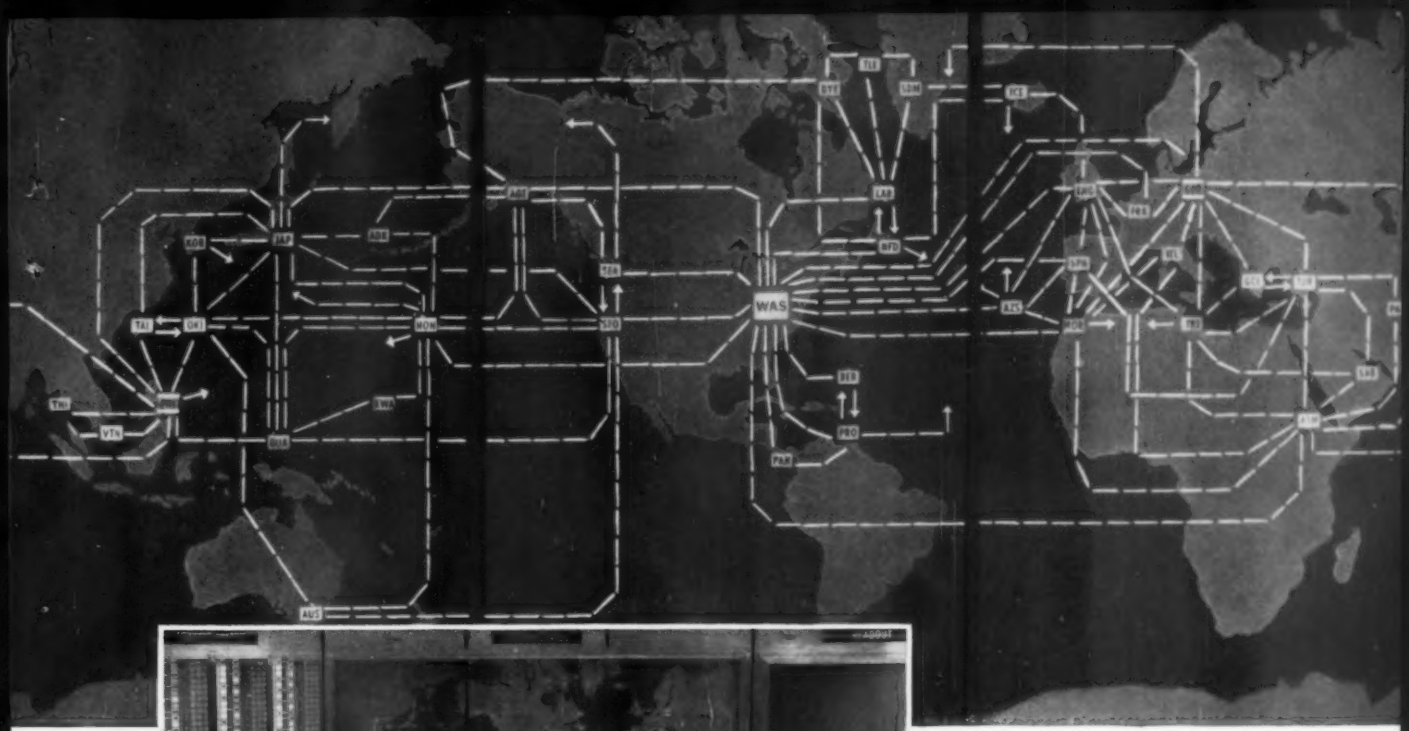

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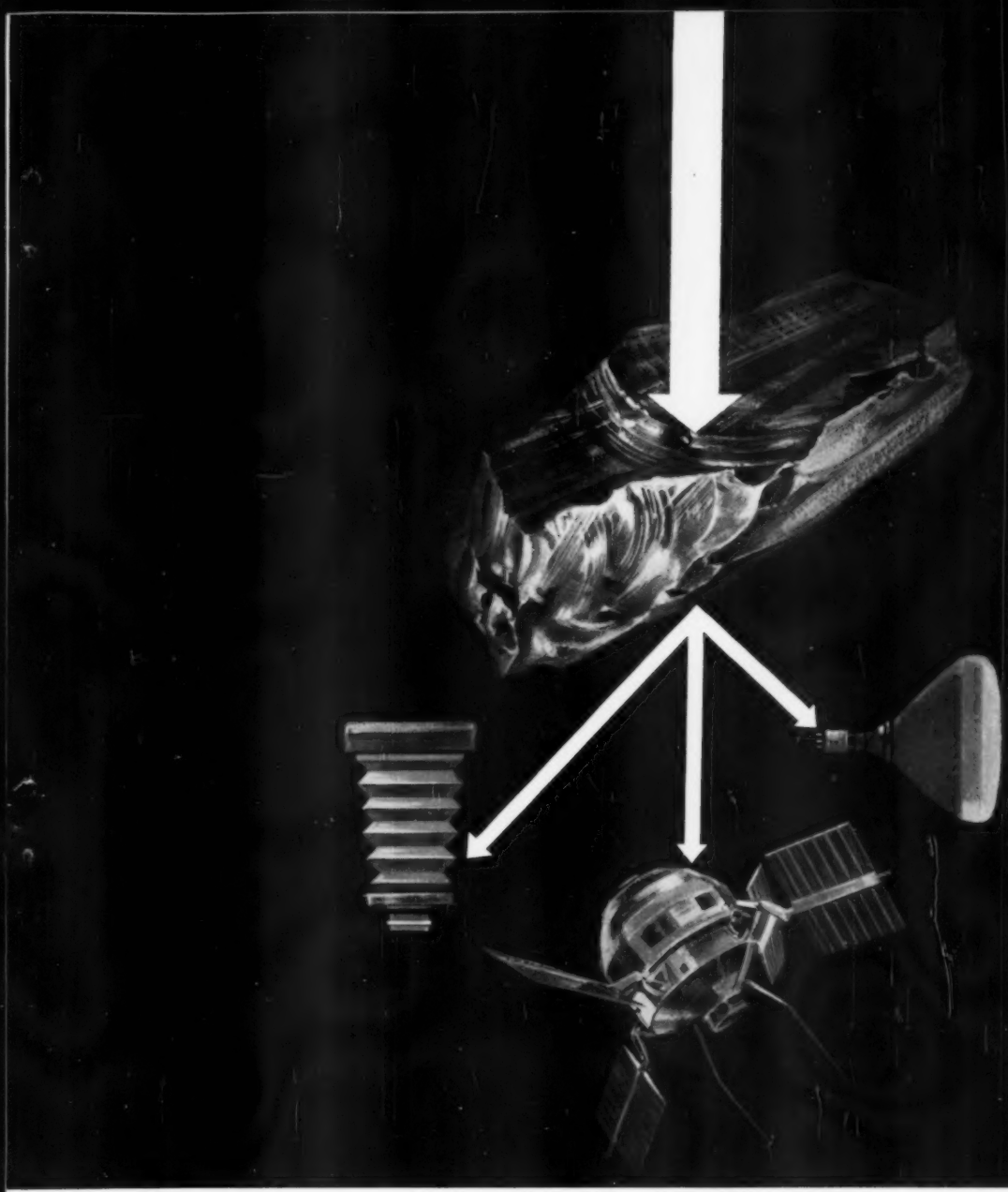

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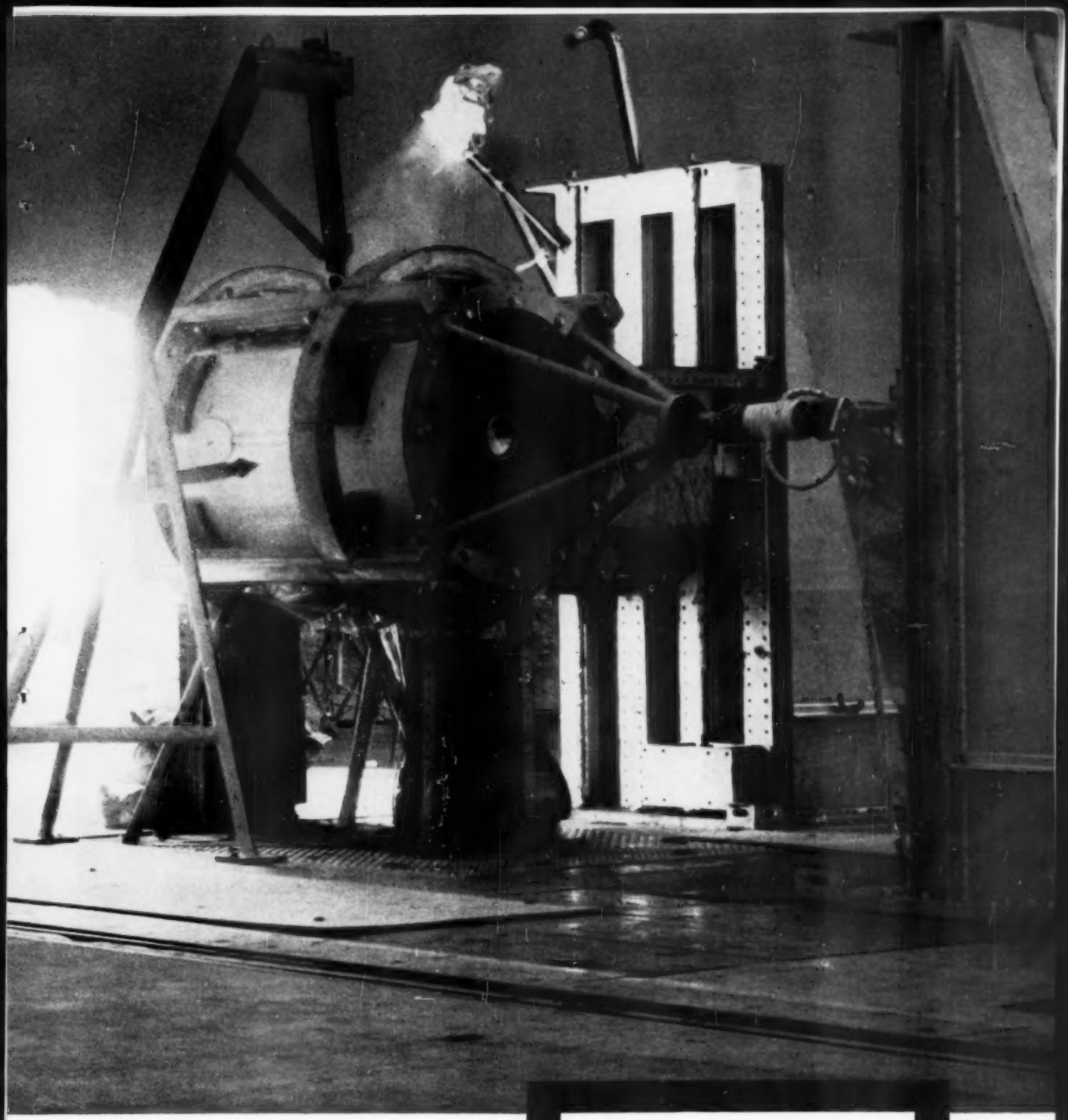
HERE'S HOW WE MEASURE MISSILE MUSCLE

This is one of the test-bays at the Hercules-owned-and-operated plant at Bacchus, Utah. Here the third-stage engine for the Minuteman rocket was developed and is manufactured for the Air Force. The advanced second-stage Polaris engine, developed for the Navy at Allegany Ballistics Laboratory, is also being manufactured here. Hercules' Bacchus plant is a fully integrated facility for research, development, and production line manufacture of high-specific-impulse solid-fueled rocket engines.

As each new design-idea is proved out in roaring flame, a net of cunningly placed transducers take the engine's pulse, its temperatures, check its pressures, stresses and thrusts. This welter of information is fed, at 20,000 bits



per second over 240 separate input channels, to a central data acquisition room where it is permanently recorded on synchronized magnetic tapes. Meanwhile, as many as twelve high-speed cameras exposing up to 3,000 frames a second on a quarter-mile of film, keep a visual record of everything that happens with thousandths-of-a-second accuracy.

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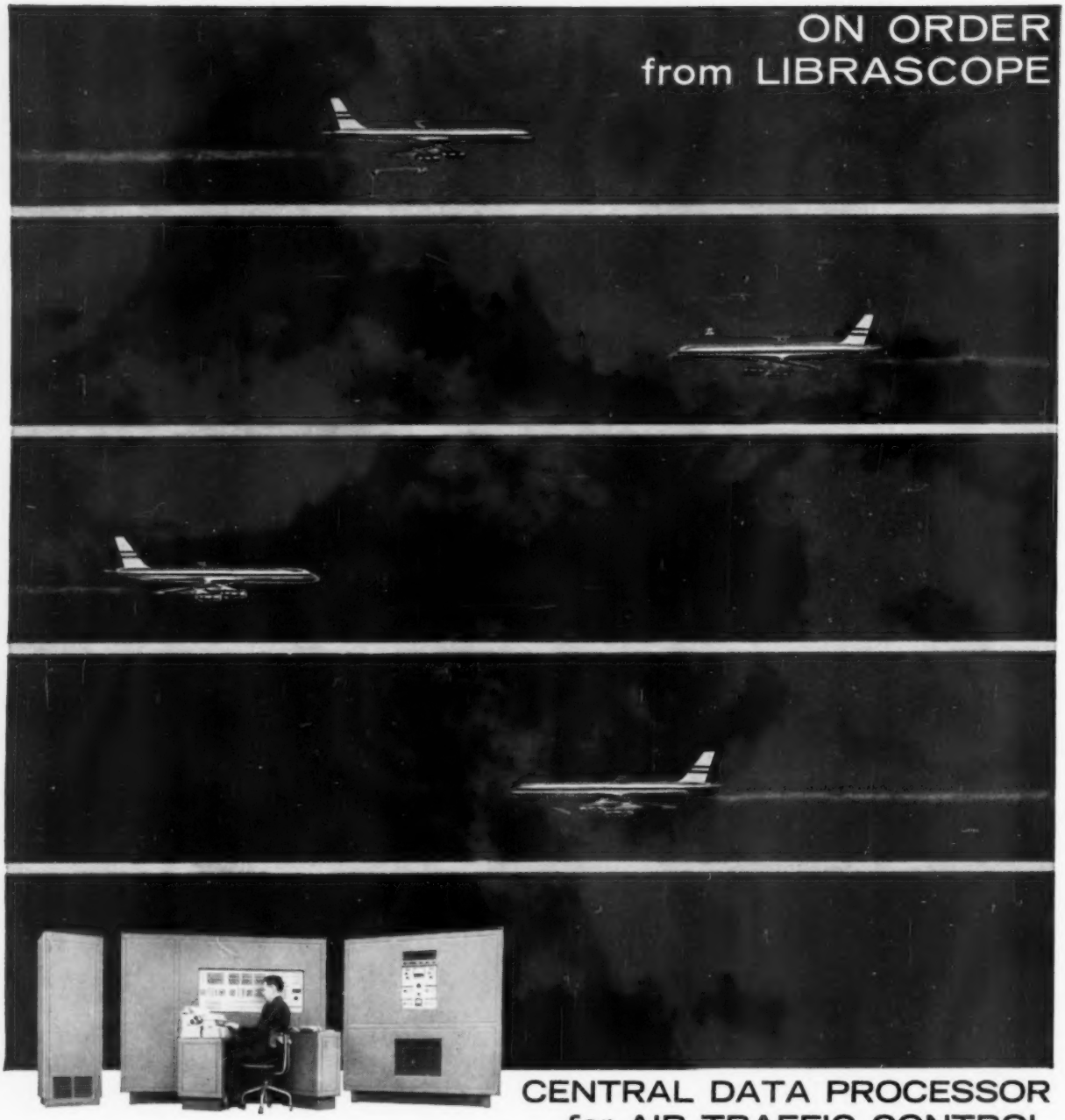

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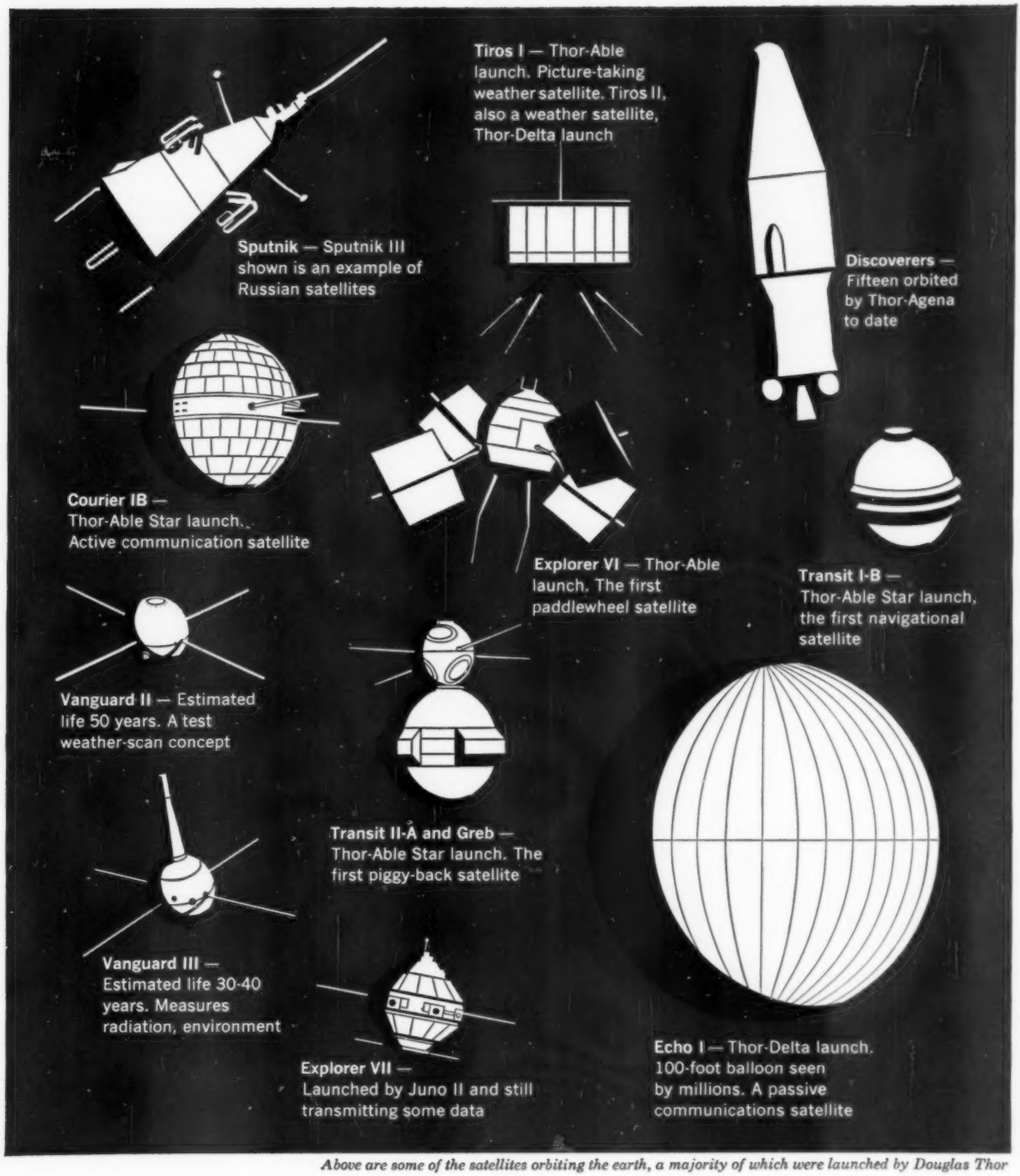
Tiros I — Thor-Able launch. Picture-taking weather satellite. Tiros II, also a weather satellite, Thor-Delta launch
Sputnik — Sputnik III shown is an example of Russian satellites
Discoverers — Fifteen orbited by Thor-Agena to date
Courier IB — Thor-Able Star launch. Active communication satellite
Explorer VI — Thor-Able launch. The first paddlewheel satellite
Transit I-B — Thor-Able Star launch, the first navigational satellite
Vanguard II — Estimated life 50 years. A test weather-scan concept
Transit II-A and Greb — Thor-Able Star launch. The first piggy-back satellite
Vanguard III — Estimated life 30-40 years. Measures radiation, environment
Explorer VII — Launched by Juno II and still transmitting some data
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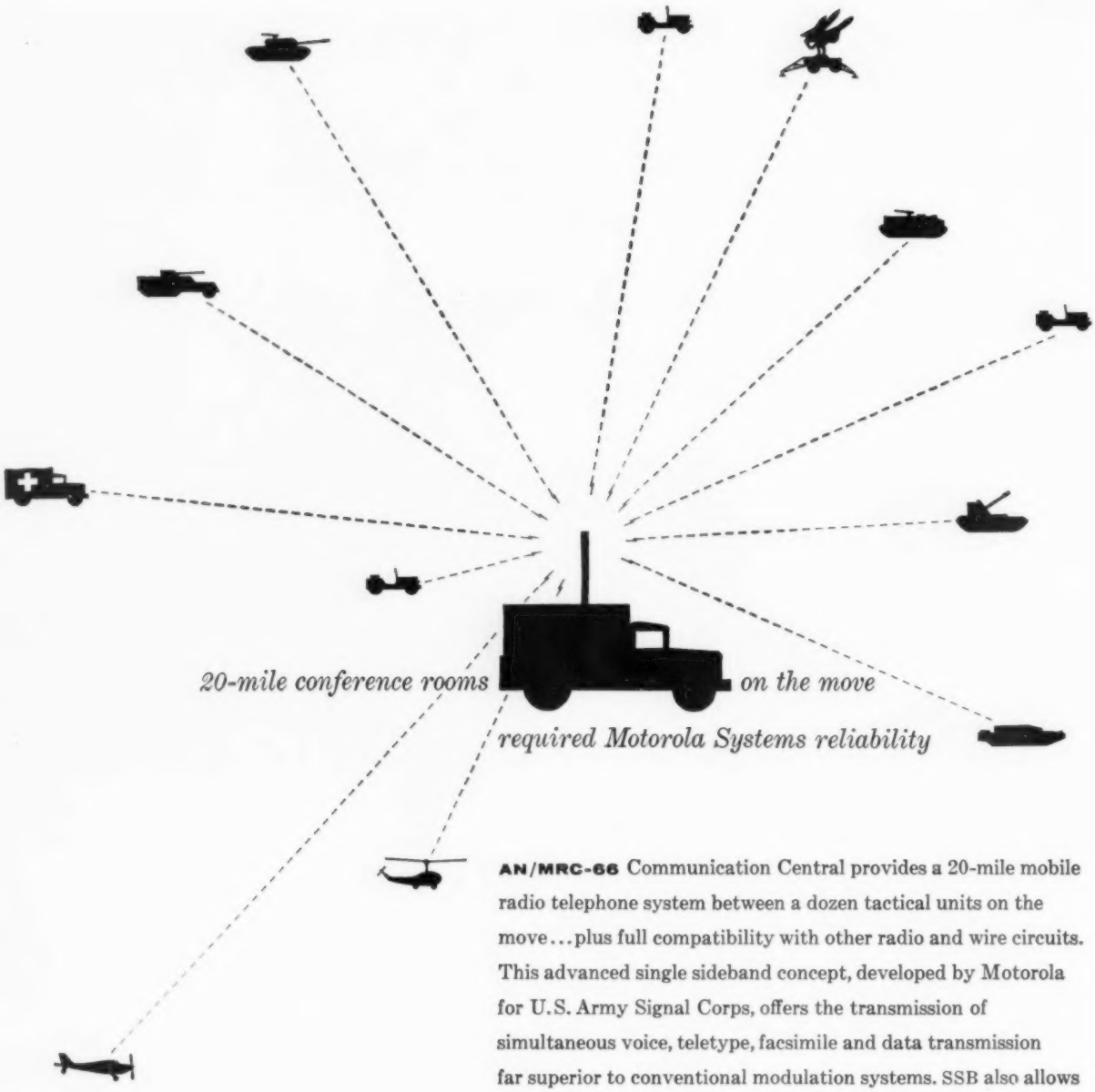

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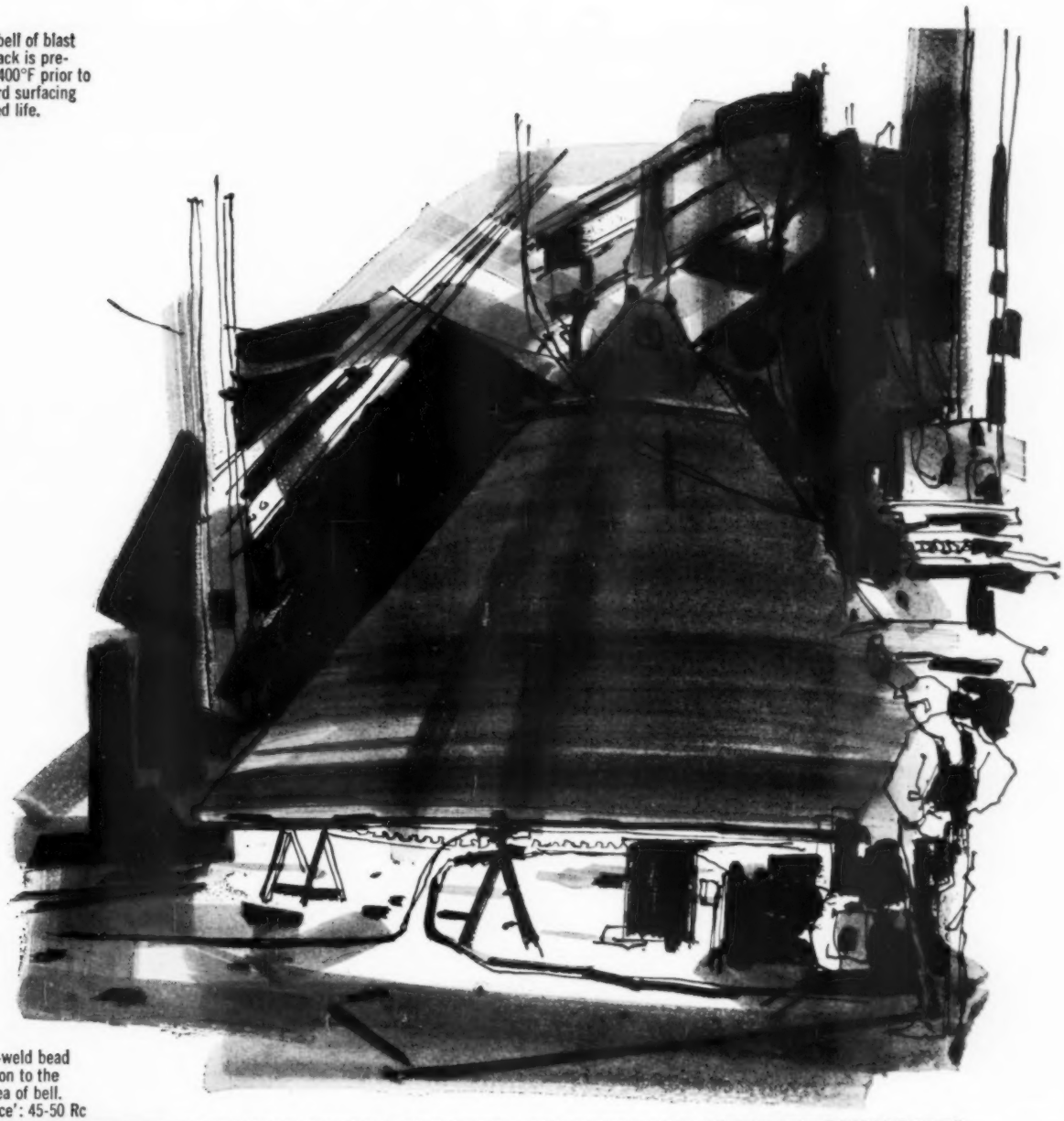

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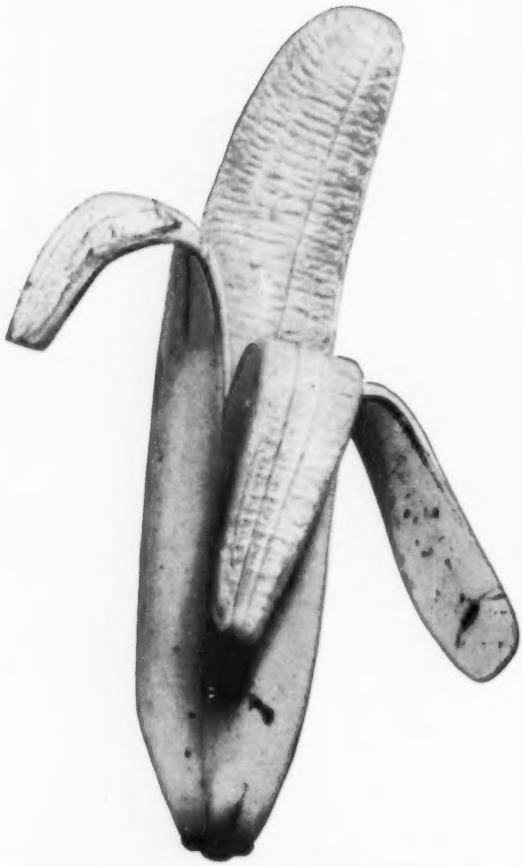

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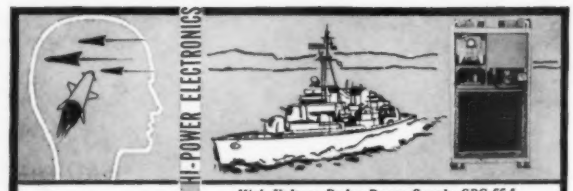

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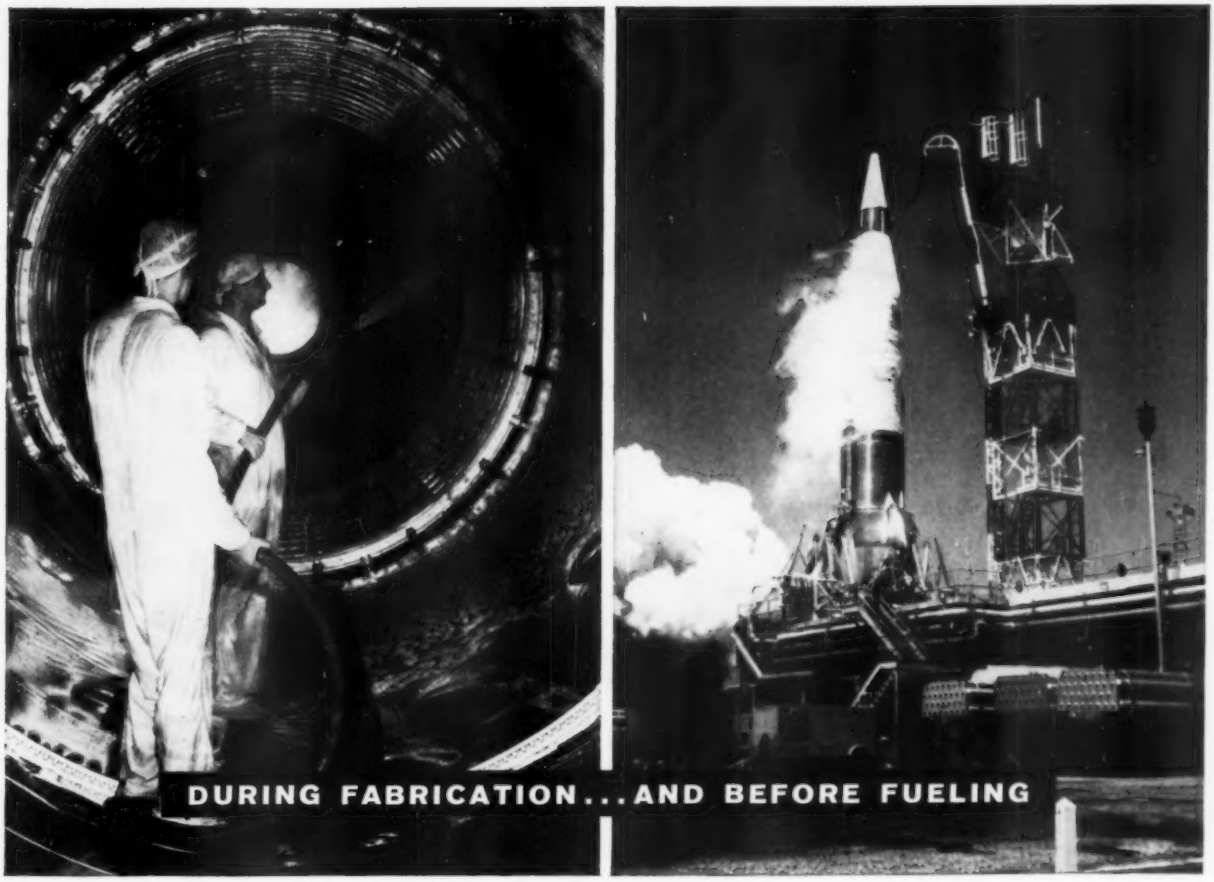

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An unexcelled background in the exacting cleaning requirements of metalworking, aircraft and ordnance manufacturing industries uniquely qualifies Oakite for the critical job of cleaning propellant systems and ground support units.

For production cleaning Oakite offers the precise solutions to match the metals and the parts. For post-production and for maintenance cleaning Oakite offers solutions that are exceptionally free-rinsing and which leave surfaces "surgically" clean. For LOX systems in particular, the Oakite program covers such procedures as alkaline cleaning, pickling, neutralizing and surface passivation.

Cleaning missile propellant systems is a job requiring expert knowledge. Make sure you have the experience of 50 years of successful industrial cleaning . . . the authoritative recommendations of the world's finest cleaning research facilities . . . the personal service of a cleaning expert. Send for the Oakite man. Meanwhile, write for this bulletin on propellant system cleaning. Oakite Products, Inc., 14F Rector Street, New York 6, N. Y.

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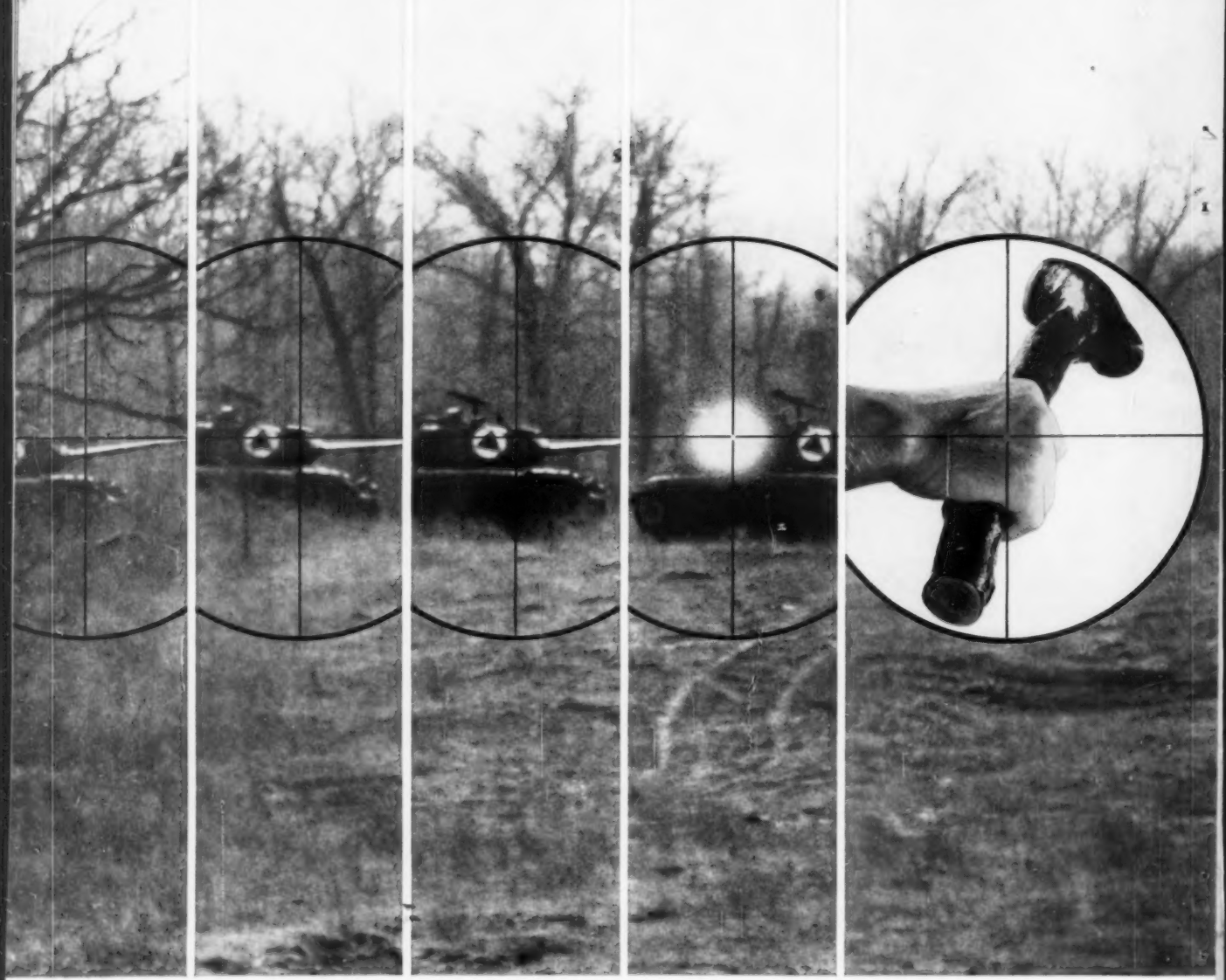
SHILLELAGH

U.S. Army Missile System



The **SHILLELAGH** is being developed for the U.S. Army under the over-all direction of the U.S. Army Ordnance Corps.

The United States Army SHILLELAGH surface-to-surface guided missile–like its Irish namesake–will be simple, reliable... lethal. Against enemy targets–moving or stationary–**SHILLELAGH**'s accuracy and firepower will provide the U.S. Army a devastating new weapon that kills with a first-round probability approaching unity ...and at ranges never achieved in antitank warfare. **SHILLELAGH** is now under development at Aeronutronic, prime contractor on this advanced weapon system.

AERONUTRONIC DIVISION *Ford Motor Company*, DEFENSE PRODUCTS GROUP
FORD ROAD, NEWPORT BEACH, CALIFORNIA

SHILLELAGH is one of many advanced programs currently under development at Aeronutronic's new, million-square-foot Engineering & Research Center at Newport Beach in Southern California.

Write for information about Aeronutronic's capabilities and career opportunities now open for engineers and scientists.

almost all major cities are defended with systems -

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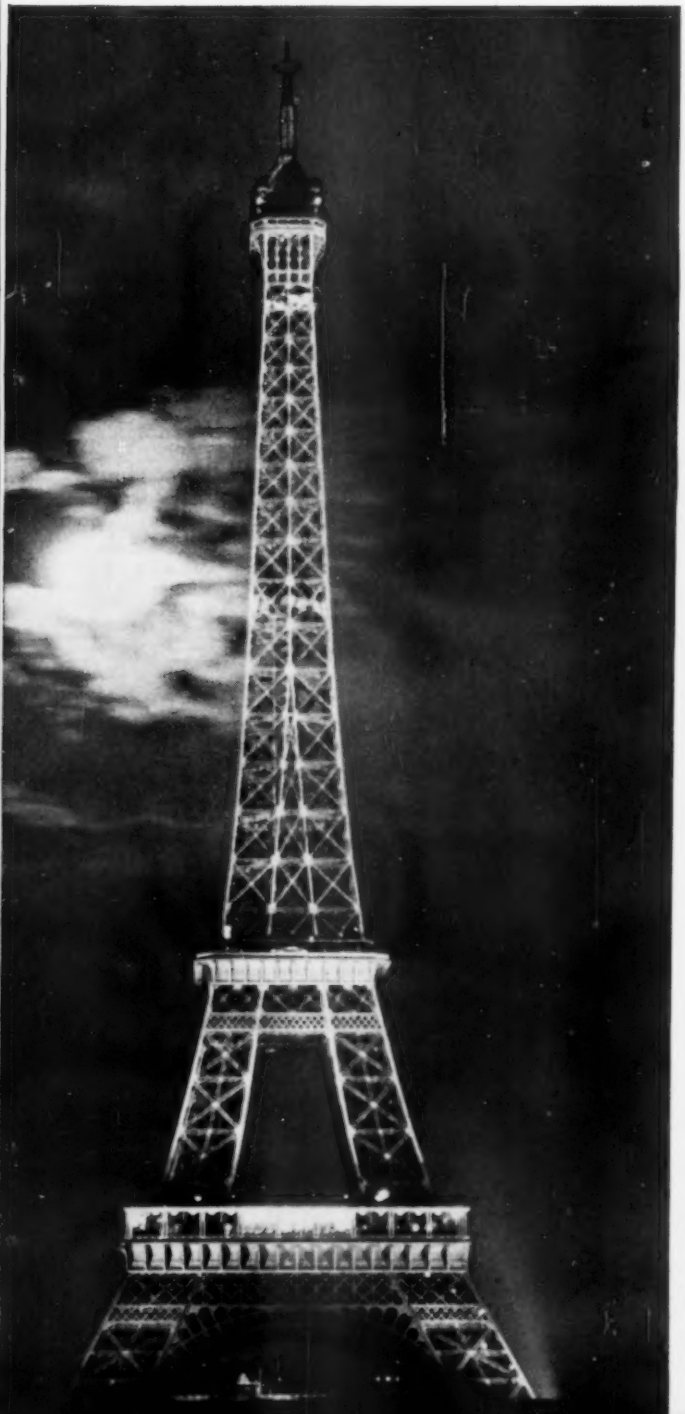

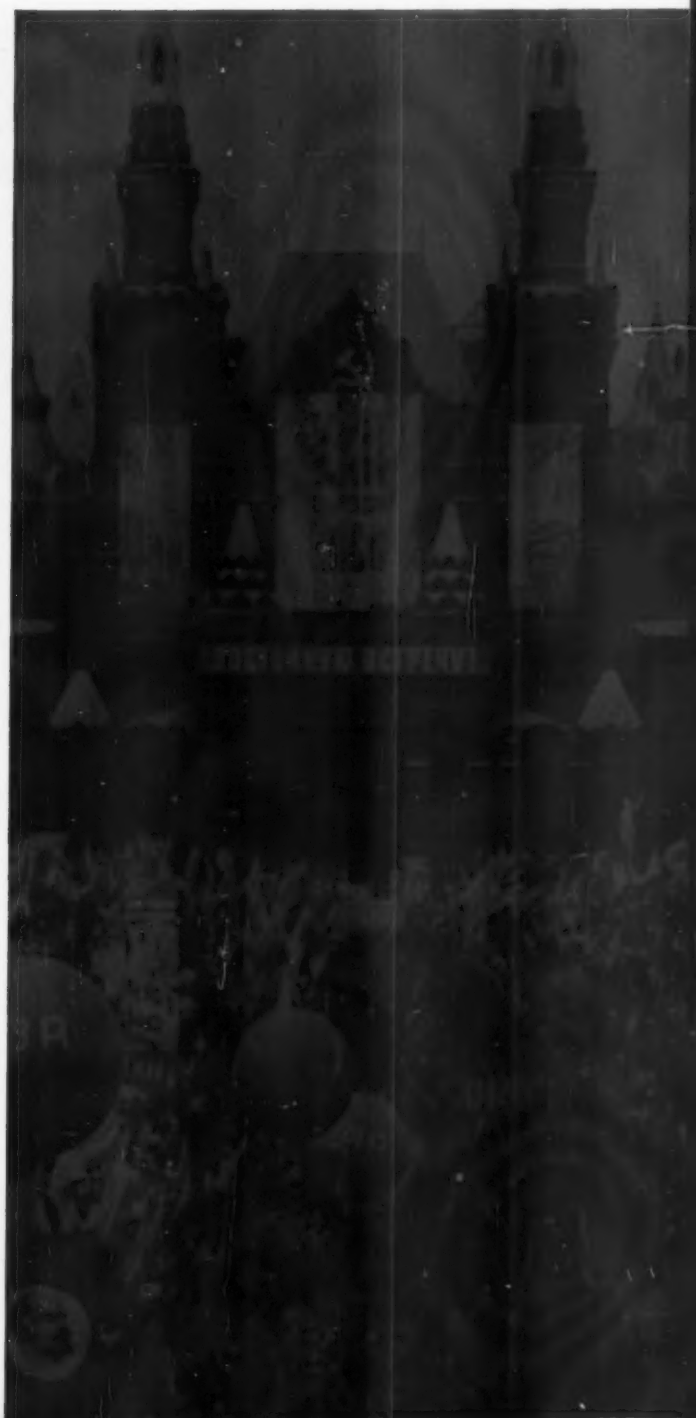

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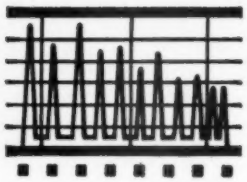
on a panel or a chart 

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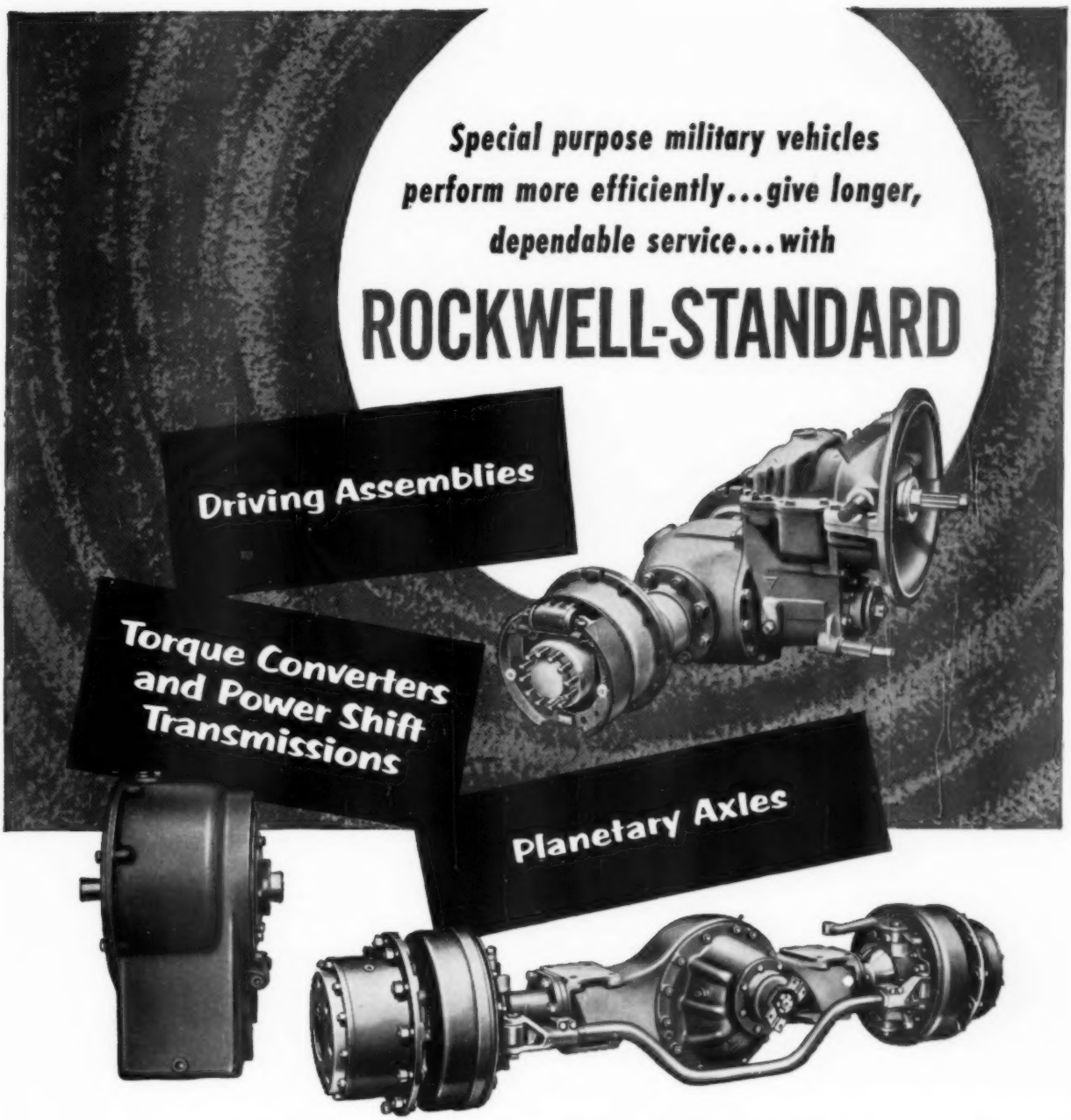

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The component you think is "special"—and expensive to build—could well be a standard item in Rockwell-Standard's *full line of driving assemblies and planetary axles, torque converters and power shift transmissions.*

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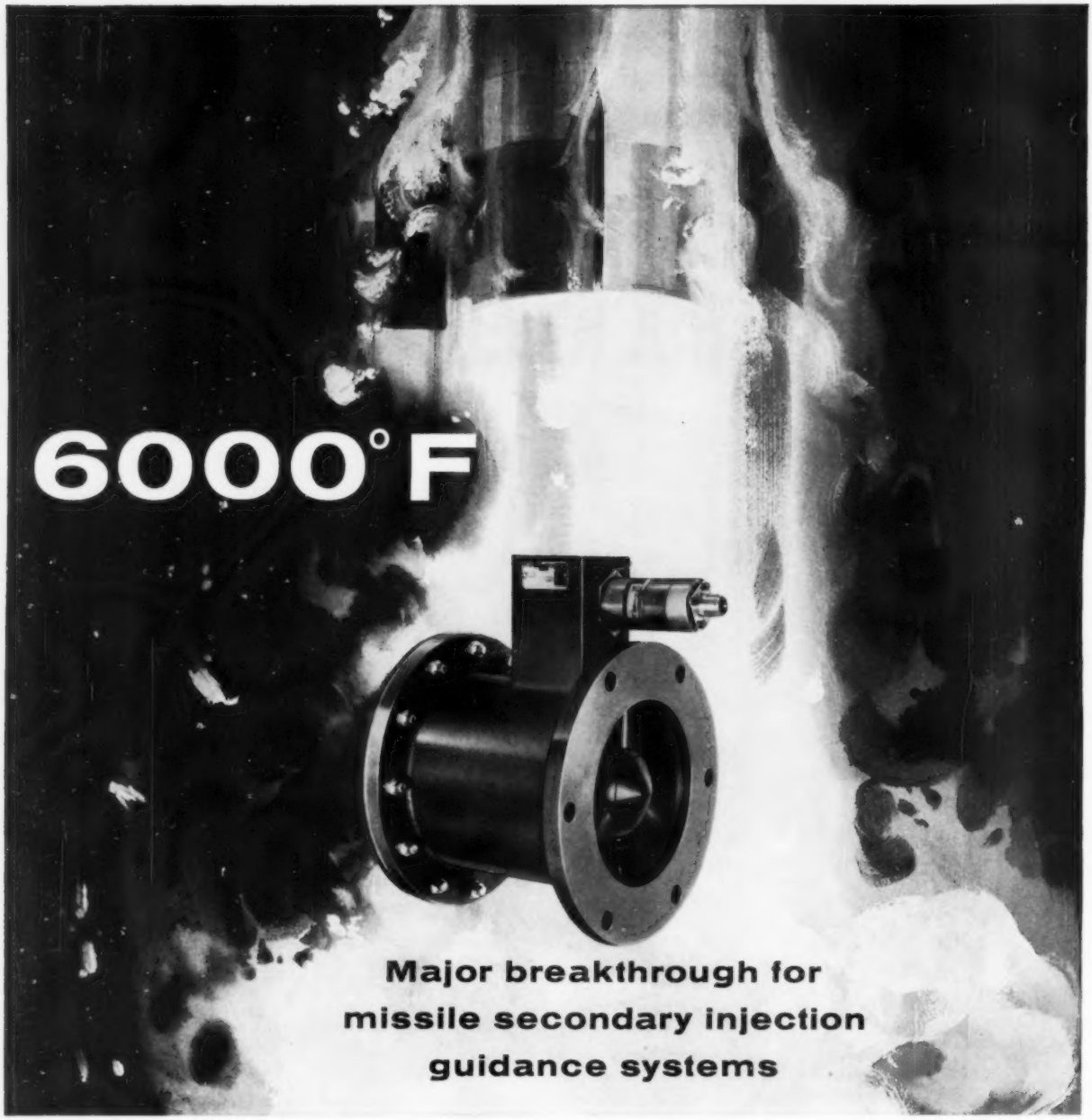

This AiResearch ultra-high temperature shutoff valve has been tested at 6000°F. Its development makes possible the use of secondary injection thrust vector control for greater simplicity and reliability.

This high temperature capability is an extension of previous AiResearch valve and controls experience in the —423 to 2000°F range, and further demonstrates over-all capability in the design of complete missile and ground support systems.

An inline poppet valve of extremely clean design has been produced to handle the high speed flow of hot, contaminated gas ducted from the combustion chamber to the exhaust nozzle. This design will: (1) keep lodging of contaminants to a minimum; (2) reduce turbulence and uneven wear; and (3) permit only a small pressure drop across the valve at maximum flow.

Growth into high temperature ranges can be accomplished by changes in material without changes in the basic valve design. The extreme compactness and light weight of the valve make it ideally suited for installation in the isentropic spike of a plug nozzle.

• *Please direct inquiries to Control Systems Project, Phoenix Division*

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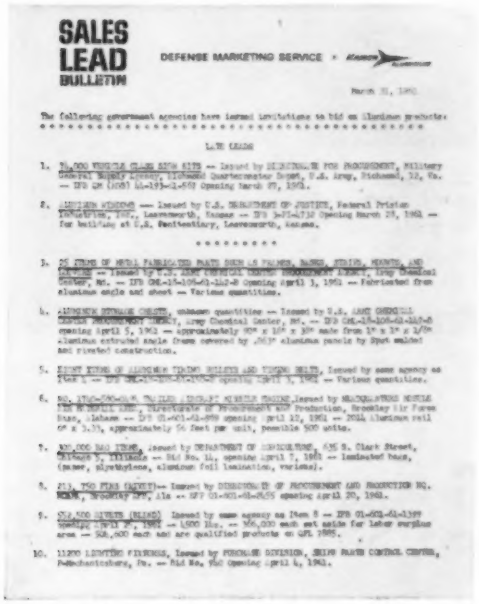

SALES LEAD BULLETIN

DEFENSE MARKETING SERVICE • Kaiser Aluminum

March 31, 1961

The following government agencies have issued invitations to bid on aluminum products:

LATE SALES

1. 30,000 VEHICLE CLEAN KITS — Issued by HEADQUARTERS FOR PROCUREMENT, Military District, Military Postal, Richmond Quartermaster Depot, U.S. Army, Richmond, 32, Va. — IFB QM (ICS) 61-193-61-569 Opening March 27, 1961.

2. ALUMINUM WINDOWS — Issued by U.S. DEPARTMENT OF JUSTICE, Federal Prison Industries, Inc., Leavenworth, Kansas — IFB 3-71-6710 Opening March 29, 1961 — for building at U.S. Penitentiary, Leavenworth, Kansas.

* * * * * * * * *

3. 25 ITEMS OF METAL FABRICATED PARTS SUCH AS FRAMES, RACKS, STRIPS, MOUNTS, AND COVERS — Issued by U.S. ARMY CHEMICAL CENTER PROCUREMENT AGENCY, Army Chemical Center, Md. — IFB DAC-18-108-61-L12-8 Opening April 1, 1961 — Fabricated from aluminum angle and sheet — Various quantities.

4. ALUMINUM STORAGE CHESTS, unknown quantities — Issued by U.S. ARMY CHEMICAL CENTER PROCUREMENT AGENCY, Army Chemical Center, Md. — IFB DAC-18-108-61-L12-6 Opening April 3, 1961 — Approximately 80" x 108" x 80" made from 1" x 1" x 1/8" aluminum extruded angle frame covered by .063" aluminum panels by Spot welded and riveted construction.

5. SHORT RUNS OF ALUMINUM TRIMS, BILLETS AND TUBING BILLETS, Issued by some agency as Item 1 — IFB DAC-18-108-61-L12-7 Opening April 3, 1961 — Various quantities.

6. NO. 17CO-500-61-8, TRAINER, TURRET MISSILE FIRING, Issued by HEADQUARTERS MISSILE AND ROCKET AGENCY, Directorate of Procurement and Production, Brookley Air Force Base, Alabama — IFB 61-401-61-8PR Opening April 12, 1961 — 2024 Aluminum roll 60" x 3.5", approximately 50 feet per unit, possible 500 units.

7. 80,000 BAG TIERS, Issued by DEPARTMENT OF AGRICULTURE, 635 S. Clark Street, Chicago 5, Illinois — Bid No. 11, opening April 7, 1961 — Laminated bags, (paper, polyethylene, aluminum foil lamination, various).

8. 211 TWO PIER CARGOES— Issued by DIRECTORATE OF PROCUREMENT AND PRODUCTION HQ. MOBILE, Brookley AFB, Ala — IFB 61-401-61-8.55 opening April 20, 1961.

9. 672,000 LUMENS (BLIND) Issued by same agency as Item 8 — IFB 61-401-61-1199 opening April 6, 1961 — 1,000 lbs. — 336,000 each set aside for labor surplus area — 528,000 each and are qualified products on QPL 7885.

10. 11200 LIGHTING FIXTURES, Issued by PURCHASE DIVISION, SEIFE PLANT CONTROL CENTER, Pedrichestown, Pa. — Bid No. 760 Opening April 4, 1961.

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It tells you what aluminum equipment is up for defense bids.

Kaiser Aluminum's weekly Sales Lead Bulletins are the only comprehensive source that alerts you to upcoming defense projects involving aluminum. ■ These bulletins are an exclusive highlight of Kaiser Aluminum's Defense Marketing Service. This unique service also offers you invaluable assistance in diversifying to other markets, military or commercial. ■ In addition, you can rely on our nationwide staff for: (1) basic assistance in preparing defense bids, (2) recommendations for alloys and methods best suited to a profitable bid, (3) technical and metallurgical assistance in production phases following bid awards. ■ Would you like to get the full scope of our Defense Marketing Service? Write us today on your company letterhead. Kaiser Aluminum & Chemical Sales, Inc., Dept. 847, 300 Lakeside Drive, Oakland 12, California.

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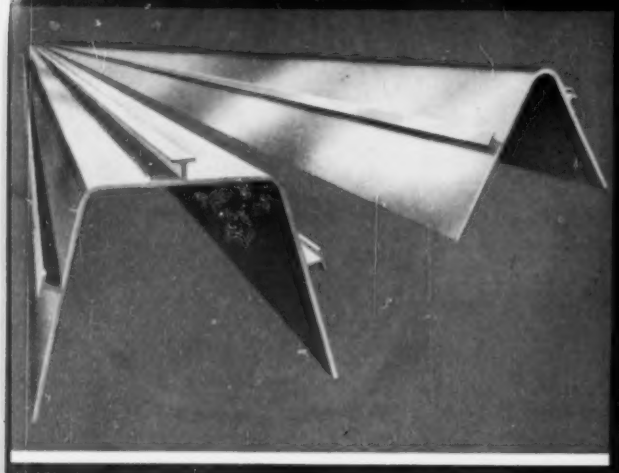
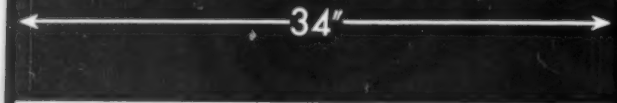
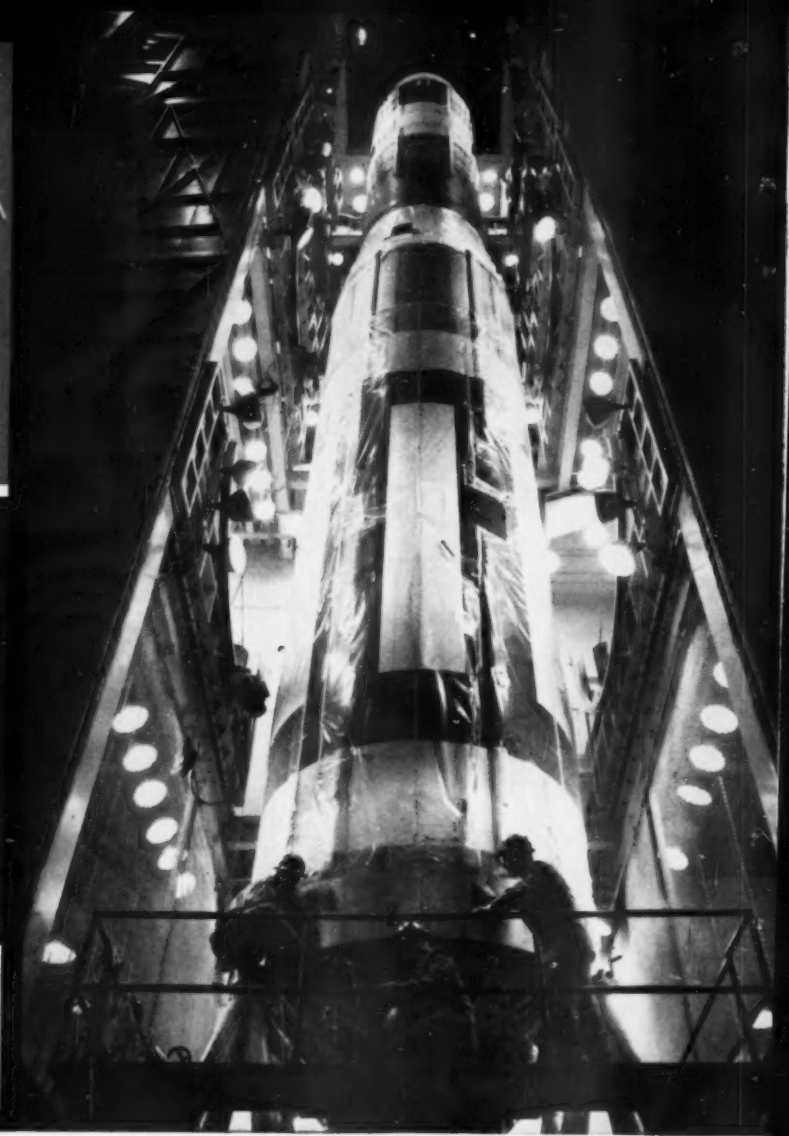




These giant panels are extruded in U-shape with three stiffening ribs, or V-shape with two (top photo) . . . then flattened to close tolerances (lower photo).



The Martin Company photo

DOW EXTRUDES GIANT 34"-WIDE ALUMINUM PANELS FOR TITAN

At Dow's Madison, Illinois, plant, a huge 13,200-ton press extrudes big aluminum panels with integral stiffeners for the Air Force Titan missile. The panels are so wide—34 inches—that they must be extruded with a "U" or "V" cross-section, then flattened and straightened. Panels with three stiffeners get the U-shape; with two stiffeners, the V-shape.

These aluminum 2014 alloy panels are flattened in Dow's contour-correction equipment to close tolerances, then straightened in a 1,000-ton stretcher.

The Dow Metal Products Company's years of large-extrusion experience include production of big parts for aircraft and ordnance equipment, as well as for missiles. Dow's Madison plant is in high-volume production of many different extruded shapes and sizes, in a wide range of aluminum alloys . . . including extrusions with circumscribing circle sizes up to 30 inches, and as long as 80 feet. For information, write The Dow Metal Products Company, Midland, Michigan, Merchandising Dept. 1102DF7.

DOW

THE DOW METAL PRODUCTS COMPANY

Division of The Dow Chemical Company

ATOMIC ENERGY

New AEC Office

The Atomic Energy Commission has established an Office of Industrial Participation, designed to strengthen industry's participation in the U. S. atomic energy program.

The over-all objectives of the new office for bolstering the Commission's cooperation with U. S. industrial organizations are threefold:

1. Provide a focal point for industry to obtain information on opportunities for private participation and investment in the development and use of atomic energy for civilian purposes and for support of Government programs.

2. Study industrial-type activities now being or to be performed by AEC operating contractors which might be carried out by private industry and recommend to the Commission policies, plans, and programs for the transfer of such activities to industry when warranted.

3. Appraise and report on the effectiveness of the Commission's policies and plans for broadening industry's participation in the program.

Radiation in Firefighting

Two new instruction programs for helping firemen learn how to cope with radiation hazards in fighting fires have been prepared by the U. S. Department of Health, Education and Welfare and the Atomic Energy Commission. The AEC Office of Industrial Relations and the Division of Vocational Education, U. S. Office of Education, have cooperated in the joint effort.

The importance of training firemen and other public-safety personnel to deal with fires and other emergencies involving radioactive materials has long been recognized by the Atomic Energy Commission. For several years a small AEC field staff has provided a limited program of direct training to members of fire departments upon request.

As a forerunner to additional training materials, a 4-hour orientation unit entitled "Peacetime Radiation Hazards in the Fire Service" has been prepared. It consists of an instructor's guide, a students' manual, and twelve illustrative charts for use by the instructor. The unit is intended for presentation to large numbers of professional and volunteer firemen as part of their basic training and to prepare them for more specialized instruction later.

The general aim of the unit is to

(*Continued on page 31*)

The CONTINENTAL T72-T-2 HELICOPTER TURBINE

▶ **PERFORMANCE** . . . 500 SHP with high economy (0.67 SFC) . . . multifuel capability (all JP, Diesel, kerosene, gasoline).

▶ **RELIABILITY** . . . due to ruggedness and simplicity of design. Sturdy 2-stage compressor . . . all-steel rotating system, foreign object-tolerant . . . anti-icing inlet . . . fail-safe dual-element fuel pump . . . trouble-free fuel distribution . . . emergency fuel circuit with manual controls.

▶ **INSTALLATION ADVANTAGES** . . . Extreme compactness (19-inch maximum diameter; 42-inch overall length) . . . straight-out rear exhaust without obstructions or turns . . . front power output on engine center line . . . front reduction gear surrounded by cool air . . . high accessibility (all accessories mounted around waist) . . . Optional mounting—single-plane, two-plane, or cantilever . . . 210 pounds total weight.

THE HERITAGE OF THE T72-T-2

The Continental T72-T-2 Helicopter Turbine has evolved directly from the highly successful J69, use-proven powerplant of the Cessna T-37 Trainer and the Q-2C Target Missile. It incorporates the same annular combustor system, same axial and centrifugal compressors, same axial turbines, and same static structure that have withstood 40,000 test stand hours and more than 1,000,000 hours in flight . . . LIKE ALL CONTINENTAL ENGINES, THE T72-T-2 IS BACKED BY PARTS AND SERVICE ALL OVER THE WORLD.

▶ They add up to HIGH OPERATING ECONOMY, with LONG LIFE, LOW TOTAL INSTALLED WEIGHT, LOW INSTALLATION PERFORMANCE LOSSES —and LOW INSTALLED COST.

FOR DETAILED INFORMATION, ADDRESS:

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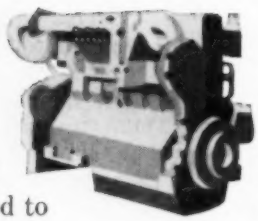

Problem: To develop more horsepower without increasing diesel engine size. *Needed:* A new method to increase fuel burning capacity without robbing engine horsepower. *Developed:* A responsive turbocharger being used in Caterpillar's compact, high horsepower diesel engines. This advance in engine efficiency was the result of a Caterpillar research group which devoted itself exclusively to turbo study and testing. Today, the company is one of the world's leading authorities on high-speed rotational phenomena, the problem and their control. • In conjunction with turbocharger manufacturers, Caterpillar has also pioneered in the field of turbocharged engine performance and proper matching of turbo and engine. As a leading manufacturer of heavy equipment, Caterpillar has outstanding resources in research, engineering and manufacturing. This experience, talent and manufacturing capacity are available for your vehicle, engine and component needs. Write for Bulletin No. 40-20265, Defense Products Department, Caterpillar Tractor Co., Peoria, Illinois.

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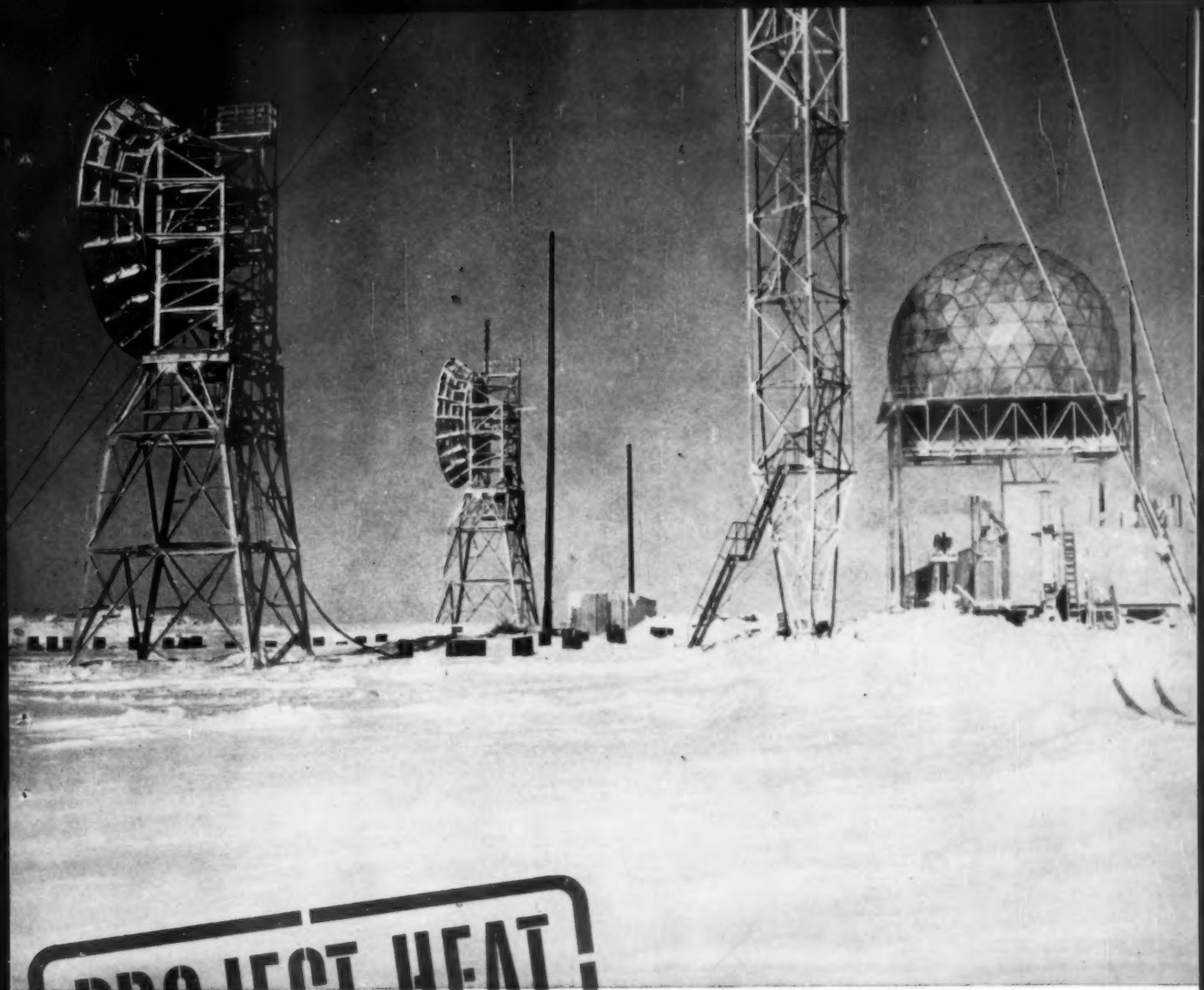

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FOR MILITARY APPLICATIONS

In cooperation with research and engineering commands of the U.S. Armed Forces, Hunter Manufacturing Co. for more than twenty years has specialized in the design, development and manufacture of multi-fuel-burning heating systems.

Hunter heating systems with *sealed-in-steel* combustion are employed for a wide variety of military uses—for space and personnel heating in mobile shelters, in portable or fixed structures of many different types, in self-propelled vehicles, in ground support systems for missiles, in radar and microwave systems, etc.

Other types of Hunter systems are widely used in winterization operations, for engine pre-heating, for emergency heating requirements and for many other using arm operations. Hunter heating systems are designed for cold starts down to 65° below zero and are air-circulating in type with thermostatic controls. Uncontaminated heat capacities range from 15,000 to 300,000 BTU/hour.

If you have a problem involving the application of heat, Hunter can help you solve it.

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SPECIALISTS IN HEAT FOR MILITARY APPLICATIONS

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Fly it...
'chute it...
shoot-and-run with it...
ALCOA ALUMINUM MAKES IT MOBILE
Official U.S. Army Photograph

Atomic Energy (Contd.)

familiarize firemen with such facts as the following:

That radioactive materials in ordinary use do not make other things radioactive;

That in general the most serious effect of a radiation incident will probably come about from contamination of the surrounding area, and the problem will be reduced to the extent that the contamination spread is limited during fire-fighting operations;

That an explosion which might occur in the use of radioactive material will be of a chemical nature and will not result in an atomic-bomb type of explosion.

The 4-hour orientation program will be followed by a 15-hour basic course to be published in midsummer. It will include an instructor's guide, student's information manual, student work assignments, and twenty-two charts. This program will enable qualified firemen and selected instructors to train others in their own local communities to deal with radiation emergencies.

Simulated Underground Tests

Pennsylvania State University geophysicists are setting off simulated explosions and earthquakes in a 26-inch model of the earth to improve methods for detecting underground nuclear blasts. Elastic waves generated in the experiments are so faint that only the most sensitive detection apparatus on the surface of the model can record the shock produced.

Specifically, the studies seek to determine the following:

1. The difference in the pattern of arrivals of seismic pulses as a function of direction from simulated fault and explosive sources.

2. The effects of different simulated geologic conditions such as thickness of the crust and variation of physical properties on the transmission of seismic pulses.

New Research Program

The AEC has adopted a new research program for high-temperature materials and high-performance reactors which would use some of the equipment and facilities previously used in the aircraft nuclear propulsion program and the services of some of the employees of the two prime contractors who were engaged in that program, now terminated.

Approximately $19,900,000 would be expended in fiscal year 1962 for the new program. Of this amount, approximately $6,700,000 would be expended for high-temperature materials research—$4,500,000 by the General Electric Company, $1,000,000 by the Pratt & Whitney Division of United Aircraft Corporation, and $1,200,000 by the Oak Ridge National Laboratory—and approximately $13,200,000 would be expended for development of a high-performance reactor experiment by the Pratt & Whitney Division. The Commission has requested new appropriations of $25,000,000 for the program.

New Element Discovered

An isotope of element 103 was discovered recently by a team of scientists at the Lawrence Radiation Laboratory, operated for the Atomic Energy Commission by the University of California.

The name Lawrencium (chemical symbol Lw) has been suggested for the new element in honor of the late Ernest O. Lawrence, Nobel prize winner, inventor of the cyclotron and founder of the laboratory which now bears his name.

The discovery was made by nuclear chemists Albert Ghiorso, Torbjorn Sikkeland, Almon E. Larsh, and Robert M. Latimer of the Lawrence Radiation Laboratory.

The element 103 isotope is the first to be discovered solely by nuclear methods. No chemical techniques were used in its identification.

The new element was created by bombarding a target consisting of three-millionths of a gram of Californium (element 98) with boron 10 and boron 11 nuclei having energies of about 70 million electron volts.

Spectral Shift Control

The Babcock & Wilcox Company's Critical Experiment Laboratory near Lynchburg, Va., is conducting experiments on the feasibility of a new nuclear reactor concept called "spectral shift control."

In concept, a "spectral shift control reactor" (SSCR) would use varying mixtures of ordinary and heavy water (H_2O and D_2O) as coolant, moderator, and partial control agent. The basic idea is that, by varying the concentrations of light and heavy water as a moderator, it is possible to compensate for reactivity changes by taking advantage of the change in neutron energies (spectral shift) which occurs in the core of a reactor as fuel is consumed and poisons are built up.

At the beginning of the core life of an SSCR, higher concentrations of heavy water would be used. This would hold down the number of fissions caused by thermal (relatively slow) neutrons, but would allow epithermal (faster than thermal) neutrons to cause fissions and also to be absorbed profitably in fertile material to produce more fissionable material. Then, as fuel is consumed and poisons are built up, the reactivity loss would be compensated by increasing the proportion of light water. This would allow more fissions by thermal neutrons, increasing the reactivity correspondingly.

Official U.S. Army Photograph

ALCOA ALUMINUM MAKES IT MOBILE

"Lean, mobile, powerfully armed and dispersed units" . . . these are basic to our new defense posture. Among the metals, *aluminum* alone possesses the unique characteristics that make it possible to:

Deliver an armored tank by air
Drop a howitzer by 'chute
Give the soldier a hand-carriable anti-aircraft weapon
Increase a torpedo's speed
Bear a missile's extreme heat and cold

Aluminum has done all this. It can do more. No other metal combines all these abilities: mobility, armorability, flexibility, air transportability, air dropability, field weldability, designability and availability. And no other company knows so much about aluminum as Alcoa.

Alcoa—owner of the largest and most extensive R&D facility of any light-metals company anywhere. Alcoa—possessor of the biggest complex of aluminum fabricating plants in the world. Alcoa—staffed in depth to go to work immediately on research, development, production engineering or production of any defense requirement in aluminum.

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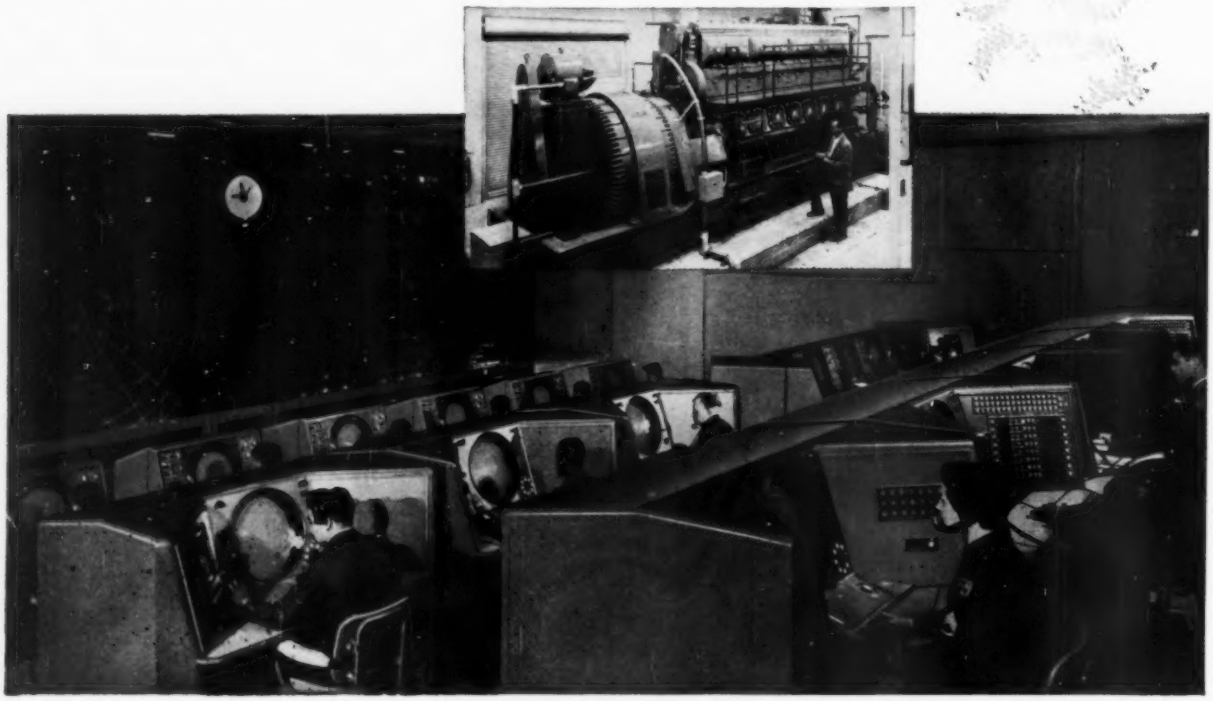
ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

WHITE SUPERIOR ENGINES



Operations Room—heart of *Missile Master*. System was designed and produced by Orlando Division of The Martin Company, in cooperation with U. S. Army Signal Corps.

...on guard with MISSILE MASTER

At U.S. Army *Missile Master* anti-aircraft installations near Pittsburgh, Chicago and Los Angeles, standby power is supplied by 8-cylinder, supercharged Model 65 White Superior engines. The 12 engines (4 at each site) develop 1415 BHP at 600 RPM to drive 1000 KW generators. The engine-generators produce precise frequency to operate radars, communication and data transmission links, visual display consoles, computers and fire integration facilities. *Missile Master's* electronic system provides semi-automatic coordination and fire direction for Nike missile batteries, and has been installed near vital U.S. metropolitan and industrial centers.

Missile Master joins a growing, impressive list of Superior-powered U.S. defense assignments that are convincing evidence Superior engines provide rugged dependability, trouble-free performance and economical fuel consumption. Superior engines —215 to 2150 HP or 150 to 1500 KW—will also meet your exact power requirements. Write today for complete information.

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Hon. Elvis J. Stahr, Jr.
Secretary of the Army

Hon. John B. Connally, Jr.
Secretary of the Navy

Hon. Eugene M. Zuckert
Secretary of the Air Force

The Service Secretaries

Experience and resourcefulness distinguish the new Defense leaders

The stresses of ever-changing international fronts and the inherent problems that necessarily follow for our Defense Department emphasize the vital need for forceful, creative leadership in the Secretariat of our armed forces.

Emphasis on military preparedness has been an intrinsic part of the work of the Ordnance Association since its inception in 1919—together with a firm conviction that as a nonpolitical group it must always keep its sights on the constant need for armament foresight as well as hindsight. This is particularly so today when the portents around the globe stress that there must not be any letdown in vigilance.

The Secretaries of the Army, the Navy, and the Air Force (pictured on the opposite page) took their oath of office shortly after the change of the National Administration. All bring to their respective positions outstanding records of experience in specialized fields, with a history of courage and decisiveness to hearten the spirits of all citizens.

The American Ordnance Association pledges to the new Defense leaders its cooperation and its sincere wishes for the achievement of peace through preparedness.—THE EDITORS.

SECRETARY of the Army Elvis Jacob Stahr, Jr., on leave of absence from the presidency of West Virginia University, has had a distinguished career not only as an educator and lawyer, but also as a soldier.

During the Second World War, Secretary Stahr served overseas, principally as a combat liaison officer with the Chinese Combat Command in the China-Burma-India campaign, reverting to inactive status as a lieutenant colonel in 1946. As a civilian during the Korean war, he served as Special Assistant for Reserve Forces to the Secretary of the Army and later as a consultant to the Assistant Secretary of the Army for Manpower and Reserve Forces, earning the Army's certificate of meritorious civilian service.

Secretary Stahr, a native of Kentucky, won many honors for scholastic achievement. Among them are the Balfour National Award as the outstanding undergraduate of his fraternity, Sigma Chi, at the University of Kentucky, from which he was graduated, and the Algernon Sydney Sullivan Medallion of the New York Southern Society for leadership. A Phi Beta Kappa, he also earned a Rhodes Scholarship to study law at Merton College, Oxford University.

IN addition to an outstanding Navy war record, Secretary of the Navy John Bowden Connally, Jr., brings to his office a diverse, well-rounded background in law, business, and corporate management.

During his service aboard the aircraft carrier U.S.S. ESSEX, Adm. T. L. Sprague observed of the new Secretary that his work was in great part responsible for the success of Navy Task Group 38.1.

He saw service with the Office of the Chief of Naval Operations as well as with the Under Secretary of the Navy, where he dealt with problems of training and manpower. Mr. Connally also was directly involved in planning for the Italian invasions and saw action in the Pacific Campaign.

He was awarded the Bronze Star Medal for "heroic achievement while serving as fighter director officer aboard the U.S.S. ESSEX during a concentrated attack by enemy Japanese aircraft," and also received the Legion of Merit.

The Secretary also holds the American Defense Service Medal, the World War II Victory Medal, and the Philippine Liberation Ribbon with two stars.

Denoting the caliber of man who now serves as Navy Secretary, the accompanying citation states that he was an officer of "resourcefulness, mature judgment, and clarity of mind."

THE new Secretary of the Air Force, Eugene M. Zuckert, has served in various capacities in the educational field, and has devoted most of his professional career to public service and education.

A graduate of Yale University, Secretary Zuckert was an instructor in relations of government and business at the Harvard Graduate School of Business Administration from 1940 to 1944, where he advanced to assistant professor and later assistant dean of the school. He also was administrative head of the first advanced management course ever given at the graduate school during this period.

In addition, while a member of the Harvard faculty, the Secretary served as a special consultant to the Commanding General of the Air Force in developing statistical controls, and was an instructor in the Army Air Force Statistical Control School there.

Mr. Zuckert, a member of American Ordnance Association, following service in the Office of the Chief of Naval Operations, was executive assistant to Stuart Symington when he was administrator of the Surplus Property Administration. When Mr. Symington assumed office as Assistant Secretary of War for Air in 1946, Secretary Zuckert became his special assistant, and rose to Assistant Secretary of the Air Force in 1947.

In 1952, Mr. Zuckert was appointed a member of the Atomic Energy Commission, and served until June 30, 1954.

Sea Power in the Pacific

Our First and Seventh Fleets stand as symbols of freedom throughout the Pacific area and with their balanced forces of ships and men are ready to safeguard the rights of independent nations in that area

Vice Adm. C. L. Melson

IN the world situation today, the ability to use the sea is vital to our allies and to us. Free use of the oceans of the world is basic to our security, to our economic health, and to our future progress. Our industrial and economic strength, the greatest in the world, relies heavily on raw materials and resources which must be obtained from across the seas. Over ninety-nine per cent of the foreign trade of the United States is carried in ships.

Shipping remains the practical and economical method of bulk transport, of getting materials in the quantity we need, where we want them. Our allies depend on the use of the sea to live and to remain strong. They cannot do without the products of trade and they can get them by sea.

This is only part of the importance of sea power. Our whole system of international security—our system of coalitions among the free nations of the world—is bound together in a maritime confederation. From the common bond of the sea, our worldwide alliances gain their strength, their unity, and their mutual support.

THE President has said that the primary purpose of our armed forces is to deter war, but if war is forced upon us our ability to project our military power depends on the free use of the oceans. Through sea power the United States can fully support and sustain forces overseas, either our own or those of our allies. With the aid of the free nations of the world we stand ready at all times to ensure our unrestricted use of the seas, and in war to deny such use to an enemy. To do this, we must maintain a respected power afloat.

Admiral Melson is commander, First Fleet, United States Pacific Fleet, San Diego, Calif.

This does not mean the absolute control of 140 million square miles of ocean. But it does mean the ability to maneuver freely in those areas essential to our freedom. We must be able to maintain this control in the face of any challenge by an aggressor—above, on, or below the surface of the oceans.

Naval power provides the means to control the seas in time of war. There must be a balance of seagoing forces and seagoing weapons ready and able to exploit the special advantages inherently available at sea. A force afloat is constantly moving. It is hard to find, hard to hit. A naval force has the strategic mobility to act swiftly, precisely, and effectively and to accomplish its assigned task with a minimum of shore-based support.

Should foreign aggression occur, control of the sea can be won only by a navy with offensive power, by naval forces that are capable of operating offensively in response to any act of aggression. Naval striking power is the key to control—the key to projecting American military power of the proper magnitude where and when it is needed.

We must consider potential threats—will our country be endangered by an all-out attack with a nuclear exchange or will there be a limited war, far from our shores yet a threat to our security?

If there were an all-out nuclear attack, our ability to strike back would depend on the survival of our forces. Our ships at sea have the capacity to survive. Two of the more powerful weapons that are a part of our survival team are the Polaris submarine and the aircraft carrier.

THE Polaris submarine is the cardinal example of versatile power. It represents a remarkable ability to exploit its environment for at sea the Polaris submarine can use all its advantages of mobility, wide range, and concealment. Together with our Nation's other military power, this fleet ballistic missile system is a powerful restraint to aggression.

The aircraft carrier with her embarked air group is the closest thing to an all-purpose weapon that has ever been devised. In wartime, carrier aircraft can control the air, at sea or in an objective area. These carrier aircraft can support ground operations, strike enemy positions, and, if necessary, be a part of our retaliatory forces. All this can be accomplished from a moving airfield, picking its own location in which to operate, protected again by the sea.

The threat may come in limited warfare where the action is confined to

small areas. To counter foreign aggression, American naval forces can move into position swiftly, and the combined Navy-Marine Corps team can move into an objective area either by over-the-beach assault or by vertical-envelopment operations. Carriers, missile cruisers, destroyers, and nuclear submarines can protect these forces.

WHILE providing the wartime striking power needed, the surface forces are at the same time under the constant threat of submarine attacks. So another facet of naval power, antisubmarine warfare, is brought to bear. Particularly pointed toward this task are the Navy's hunter-killer forces—carrier aircraft and helicopters, destroyers, killer submarines, and shore-based patrol planes—all joined in concentrated, coordinated, far-ranging teams to seek out, identify, and destroy enemy submarines.

There are many other naval tasks with a degree of naval power tailored to each of them. There are many techniques that are developing and improving. Each makes its contribution to the Navy's total balanced power. There are mine forces to sweep or lay mines; ships, planes, and submarines are available for reconnaissance when needed. To maintain this flexibility and versatility, we depend on supply ships, oilers, repair ships, and tenders to sustain the fleet.

These are the material things, the hardware, the weapons, the missiles, aircraft, and ships the Navy needs to carry out its assigned tasks.

Just to assemble this power is not enough. It must be used correctly and wisely. In order to administer and operate this naval capability, the Navy is divided into two major fleets, the Atlantic and the Pacific. These two fleets are divided further into four numbered fleets, the Second and Sixth in the Atlantic, and the First and Seventh in the Pacific.

The Pacific Ocean basin covers more than 85 million square miles.

The Commander in Chief of the Pacific Fleet, Adm. John H. Sides, from his headquarters in Pearl Harbor, Hawaii, has the major responsibility for the operation of naval forces in this vast area. This force is composed of more than 425 ships, 3,000 aircraft, and 250,000 officers and men. It is obvious that the size of the area and fleet alone requires many subordinate activities in order properly to organize and maintain this naval power.

Admiral Sides has various subordinate commanders to direct the administrative requirements of the fleet. They permit the Commander in Chief to concentrate on the major problems in the Pacific, and he in turn has been provided with two operational fleet commanders who actively prosecute the commitments placed upon the Navy by our Government.

It is this force of ships and men that stand today as a symbol of freedom throughout the Pacific area. It is the American sailor, along with thousands of other Americans in uniform, who has become a familiar and friendly face to the countries of Asia during the last fifteen years.

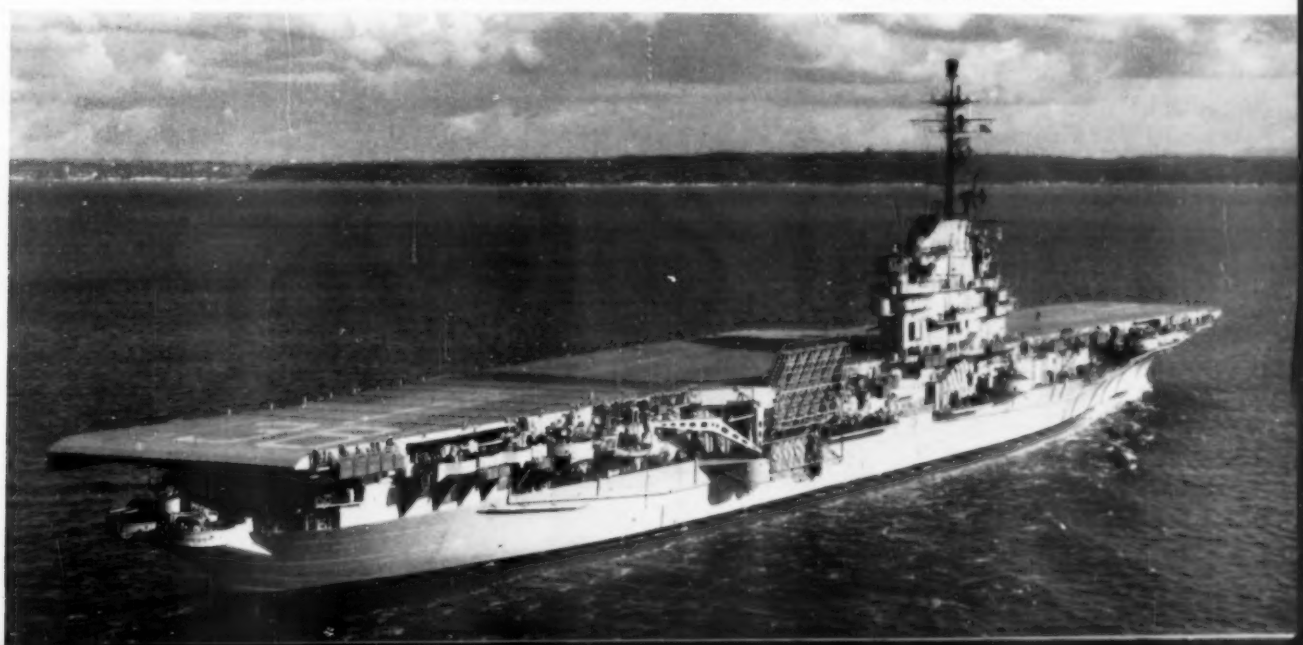
This force has stood time and again just over the horizon ready to defend against any encroachment on the rights of others, has sped food, medicine, clothing, and gentle hands to those in misery when disaster has struck, and has brought stability to areas threatened by violence.

The Pacific Fleet joins with our Army and Air Force counterparts to form the joint operating forces under the Commander in Chief of the Pacific Command, Adm. Harry D. Felt.

WHAT kind of forces must we have to meet the commitments of such a tremendous job? It is true that many of our ships are growing old. However through a program called fleet rehabilitation and modernization (Fram), certain of our ships are being modernized and given new life for another five to seven years. Seventy-five per cent of these ships are destroyers with their antisubmarine-warfare potential. Other ships scheduled for Fram include submarines, destroyer and submarine tenders, assault helicopter carriers, antisubmarine aircraft carriers, and a few amphibious ships.

With this rejuvenation program, the Navy will be able to continue its tempo of operations to meet our worldwide commitments, but it must be remembered that we will be faced with the same age problem in the near future.

Aircraft carriers are key units in the Navy's "hunter-killer" forces, vital elements of naval power (Navy photo).



New construction is bringing fine modern ships to the Fleet, but not as fast and in the numbers we need. The Pacific Fleet Forces now include nuclear submarines, Regulus-launching submarines, Terrier-missile-armed frigates, Regulus-armed cruisers, Terrier-armed cruisers, and one Talos-armed cruiser. Scheduled to report to the Pacific Fleet within the next two years are the new Talos-armed cruisers GALVESTON and CHICAGO, and the large new carriers, the U.S.S. CONSTELLATION and the U.S.S. KITTY HAWK. Also, more missile-armed ships will join the fleet in the future.

THIS influx of newer ships and Fram ships gives a minimum of forces to meet our goals. We don't have much of a margin or cushion, and our required operating time out of port is a constantly climbing figure, but we make every possible effort to keep within reasonable bounds.

Carrier forces in the Pacific Fleet today include 14 aircraft carriers of which 8 are attack carriers (CVA's), 4 are antisubmarine type (CVS's), and 2 are assault helicopter carriers (LPH's). One FORRESTAL-class carrier, the U.S.S. RANGER, has been a part of our carrier force for over two years and will be joined soon by the aforementioned two new ones.

Amphibious shipping includes attack transports and landing ships dock, landing ships tank, and utility landing craft permanently assigned to amphibious squadrons and divisions. The assault helicopters are a part of this landing force. Unfortunately, the bulk of this force is of World War II types, not only growing old but straining at the limits of the speed needed to meet today's operating requirements.

To round out the Pacific Fleet and its power, the Fleet Marine Force is an integral part. Composed of two Marine Divisions, two Marine air wings, and a Marine brigade, the Fleet Marine Force is the muscle required to complete any cycle of a military operation. The First and Seventh Fleet commanders have the responsibility of putting these forces into action.

Deployed in the Far East, the Seventh Fleet has been a major stabilizing influence in many periods of tension. Her striking power is respected by friend and foe alike.

Less well known up to now is the First Fleet which operates in the Middle and Eastern Pacific. The First Fleet commander's area of responsibility extends from the West Coast to 160-degrees east longitude, halfway between Midway Island and Japan, and from the Arctic to the Antarctic.

In order better to fulfill the requirements of the First Fleet, staff personnel are embarked in the heavy cruiser HELENA. Normally composed of approximately 105 ships, the First Fleet, with all its elements of sea power, is charged with four major responsibilities: First, be prepared to move quickly in any contingency anywhere in the Pacific; secondly, participate in planning for contingency operations in the Pacific; thirdly, provide support for the Seventh Fleet; and fourthly, keep all units in a high state of readiness and training enabling them to meet any demand placed upon them.

Today the United States occupies a unique position in the community of nations. Our country is the leader in a great international effort to establish an environment of order and justice throughout the world. Leadership has been thrust upon us by our free society, by our encouragement of human enterprise and free competition under law, and by our willingness to stand up for the principles we have preached and have continued to practice.

The world leadership of the United States depends upon our national integrity in world affairs, and our honest and sincere interest in humanity. Fundamentally, our leadership depends on our strength—on our total moral, political, economic, and military strength.

ALL of those in the armed forces know that military power is only one of our strengths. The means by which our Nation seeks to achieve its goals are primarily nonmilitary. To safeguard our own liberty and the liberty of free men throughout the world, our military strength must be maintained and continuously improved. This strength must remain responsive to our country's needs, to our allies and friends, and to our military obligations.

Helicopters play an important role in the Navy's antisubmarine-warfare tactics (Navy photo).

The Amphibious Assault

This is a vast and complicated operation, requiring the greatest teamwork among all the armed forces and also specialized weapons and techniques to put the Marines on the beach under enemy fire

Brig. Gen. S. R. Shaw, U.S.M.C.

AMPHIBIOUS assault involves, in one way or another, all the ships and weapons of a fleet, including airplanes and most of the weapons of land warfare. From the viewpoint of naval operations, such an attack always involves a major effort of ships, boats, and aircraft.

The outstanding example of this is the landing made by Allied Forces in World War II on the coast of Normandy in 1944. It has been called the largest amphibious operation in history. Five divisions of infantry were in the assault, but it is a little known fact that it was eight days before the troops ashore equaled the number of sailors on the ships and craft that landed the infantry.

Few people realize that this landing required the naval coordination of almost the entire British Fleet and the U. S. Atlantic Fleet over a period of months throughout the Atlantic and Mediterranean. This is why an amphibious assault is a naval operation, and a unique one.

THERE were two forces involved in the Normandy landing. Each organized, trained, and equipped for combat for two different purposes—one for combat on the sea and the other for combat on land. These two forces had to engage in action simultaneously and actually mix physically with each other.

Many times this mutuality of action extends down to the smallest unit such as a boat team of Marines and the sailors of the boat crew that lands them.

General Shaw, U. S. Marine Corps, is the commander of the Landing Force Training Unit, Pacific Fleet Amphibious Training Command, San Francisco, Calif.

This is a distinguishing characteristic of amphibious operations; in no other military action is there such a degree of this intermixing of forces and mutual responsibility for success.

The Navy has the responsibility for the development of the ships and craft necessary to embark and support the landing force. In carrying out this responsibility the Navy must work with the Marine Corps to be sure that the characteristics of the ships and craft are such that the landing-force requirements are adequately or reasonably met.

The Marine Corps has the responsibility for the development of weapons and equipment which are essential to the special requirements of a landing force. Most of the weapons or equipment of such a force are those of land combat and are common to the Army, as well as to a landing force. The Army carries the burden of these developments. The Marine Corps advises the Army to assure that, as far as practicable, these developments are suitable for use in landings.

The Marine Corps must obtain the development of equipment which is peculiarly of landing-force interest. A classic example of such a development is the amphibious tractor, which the noted British writer, Maj. Gen. J. F. C. Fuller, has called the development of greatest strategic significance in World War II.

The development of the doctrine for amphibious assault is of major importance since it governs the employment of weapons. This is a mutual responsibility of the Chief of Naval Operations and the Commandant of the Marine Corps. It is a national responsibility of these two officers, since the doctrine which they develop must be suitable for use by all the armed forces of the United States.

HAPPILY, this responsibility has been met with great success. The existing doctrine developed by the Navy and the Marine Corps is fully suitable and adequate for use by all our forces.

In developing weapons for such an assault, there are two or three problems: First there is the problem of developing ships which can be effective with the new techniques and equipment that modern war requires. Next, there is the problem of adding speed to the amphibious-type ship so that the strategic impact and shock can be increased to match that which we have gained tactically with the use of the helicopter. Finally, there is the problem of incorporating these changes in design in the ships which must replace the obsolescent and battleworn vessels left over from World War II.

More speed already is being incorporated in the new LST's (landing ship tanks) and in the new LSD's (landing ship dock).

A major increase in our amphibious assault capability will come from the construction of an entirely new type of amphibious ship, the LPH (landing platform helicopter—an aircraft carrier to carry helicopters), and a battalion landing team plus its air-transportable equipment and supplies.

These ships will embark at least 20 helicopters and up to 1,500 officers and men with all their organic equipment. The LPH will displace about 17,000-tons fully loaded, and have a 20,000-mile cruising range at 20 knots.

A second new and very important type of ship is the LPD (amphibious transport dock). In one hull it combines the features of our present transport, the cargo ship, and the LSD. This ship will carry about 400 Marines and their equipment, several large landing craft, and several helicopters. It will be a highly useful and versatile addition to the fleet.

The helicopter is a major development in the amphibious assault. It has completely altered, in a more powerful fashion, the form of attack which was so successful in World War II. We turned to this aircraft as a means of gaining speed and dispersion in the face of the possible use of a nuclear weapon. When the helicopter attack is combined with the surface assault across the beaches, our forces can storm hostile shores and project power farther inland more rapidly and more powerfully than ever before.

The vertical envelopment by helicopter brought about a whole train of new developments, both in equipment and tactical thinking. A search started immediately for new—or at least smaller and lighter—equipment and weapons. The introduction of each caused changes in techniques of employment.

Like falling dominoes, one idea sets off a chain reaction. In World War II we relied heavily on the telephone. The helicopter, which permits use of extended and dispersed formations, forces us to rely on radio and airborne messengers, giving birth to a whole new family of radio devices. One important member is radio relay.

Soon to be in the hands of troops is an artillery weapon using a rocket-assisted shell. It is a helicopter-transportable and fires six rounds in two seconds. The U. S. must adopt radically new theories and techniques in the use of this artillery.

Much more will be heard about the Mechanical Mule. Although simply a wagon with a gasoline motor, it is rugged, reliable, lightweight, and, with a helping hand on occasion, can negotiate almost any type of terrain. With a helicopter and mules, the Marine battalion has tactical independence.

The expeditionary landing field (ELF) is a modern air base capable of handling all Marine Corps tactical aircraft, operating in close air support of Marine ground forces. The modern jet aircraft made the temporary airfield of World War II obsolete. Equipment and material required for ELF can be carried in amphibious assault ships. The runway, which is aluminum matting seventy feet wide, withstands the tremendous heat blast of the jets and the impact of high-speed arrested landings. As matting is laid, excavations are dug for the tactical airfield fuel-dispensing system.

This portable fuel facility consists of plastic fuel cells and associated filters, meter manifolds, and dispensing lines. The fuel line has quick-disconnect fittings. It receives fuel over the beach from offshore tankers at high rates of flow.

Aircraft operations under all weather conditions are possible using portable Tacan and ground-controlled-approach units. To aid in traffic control an AMFPM 36 quad radar is installed.

The 3,400-foot runway has two mobile arresting units. One is installed on the landing end of the runway for direct arrest. The other is installed at mid-point, and is used for roll-in arrestments of heavier aircraft. The runway length also can be reduced to 2,000-feet with an expeditionary catapult and high-capacity arresting gear.

The ELF can be operational in forty-eight hours, thus greatly extending and multiplying the use of Navy and Marine carrier-type aircraft.

THE Marine Corps is developing new equipment to improve the fighting ability of the individual Marine because we recognize that this Marine is ultimately the force that must come to grips with our enemies. What are we doing to improve this equipment? A great deal.

For example, our Marines may soon be wearing a garment known as the battle jerkin. This is a vest-type load-carrying device, with snap-on pouches for rations, ammunition, entrenching tool, and canteens. It will reduce the Marine's load from sixty to thirty pounds.

The battle jerkin facilitates a balanced load and is compatible with cold-weather and other special types of clothing. Lightweight armor plate inserted in pockets inside the vest provides protection for the upper torso. These armor plates are much lighter and offer more protection than those used in Korea. In addition, our Marines will wear armored shorts to protect the lower torso.

Our researchers also have developed a new helmet. It is almost a pound lighter than the present model and provides thirty per cent more area coverage and ballistic protection. It has no liner but contains a suspension system fitted directly to the helmet.

OUR Marine also will have a new canteen. It is plastic, light, durable, and heat resistant—and costs twenty-five cents. He will sleep in a new individual shelter—a small Quonset-hut-type structure with an extension that rolls out for leg space. It stands about the same height as the old pup tent but requires no ropes or stakes, being supported by an arched air cell at either end and one air cell beam along the top. These air cells are inflated by a self-contained hand pump. The floor is tearproof nylon, and the entire package weighs less than 5 pounds.

Let's leave Marine Corps ground units and look at Marine aviation. The aircraft that will provide close air support, though not yet in the evaluation

The Marine A2F aircraft with its heavy bomb load will provide close air support in an amphibious assault.

stage, is the A2F. It will take the place of the A4D. Some of its planned characteristics are: Combat range, well over 1,000 miles; ceiling, over 30,000 feet; mission time, hours instead of minutes as for present jets; and maximum bomb capacity—several times that of World War II.

OUR new combat methods will place a premium on the individual's capacity to fight in small units and to endure the loneliness of the battlefield, so it is important to increase the individual Marine's confidence and to reduce his liability as a casualty. It is here that one of the biggest unfilled needs can be found—the armor worn by the individual.

We now have armor, and it is good as far as it goes. It protects the vital parts against relatively low velocity fragments. We need to extend this armor to cover more of the man. We need new materials and new methods for putting them together. They must be light, flexible, durable, and capable of being ventilated so that they can be worn for long periods of time.

Practical developments in this area of individual combat would add enormously to the capability of United States troops.

The area of philosophy of design applies generally to all mechanical equipment but particularly to our military vehicles.

Almost without exception, these vehicles and their power trains over the years have become more complicated, heavier, and require greater precision in building and repair and more fuel to make them go.

We certainly have paid the penalty for this type of design in past vehicles. For instance, in making the current amphibious tractor, it was necessary to go into the market for motors and transmissions then currently available. We used an 850-horsepower motor, but it took about 250 of those horses just to run the transmission, and the fuel consumption was, and is, tremendous!

The United States needs military motors and vehicles that will reverse the trend it has been following. Fuel consumption in vehicles should be reduced by at least forty per cent. Think what a forty per cent saving in fuel would mean. Out of every one hundred drums of fuel now delivered on the battlefield, forty could be forgotten. Out of every one hundred tankers that have to be built and convoyed across the ocean, forty could be saved. This is an enormous reduction in the taxpayer's military burden.

Rugged, reliable, simple, and economical vehicles are needed—and needed very badly if the amphibious assault operation is to succeed.

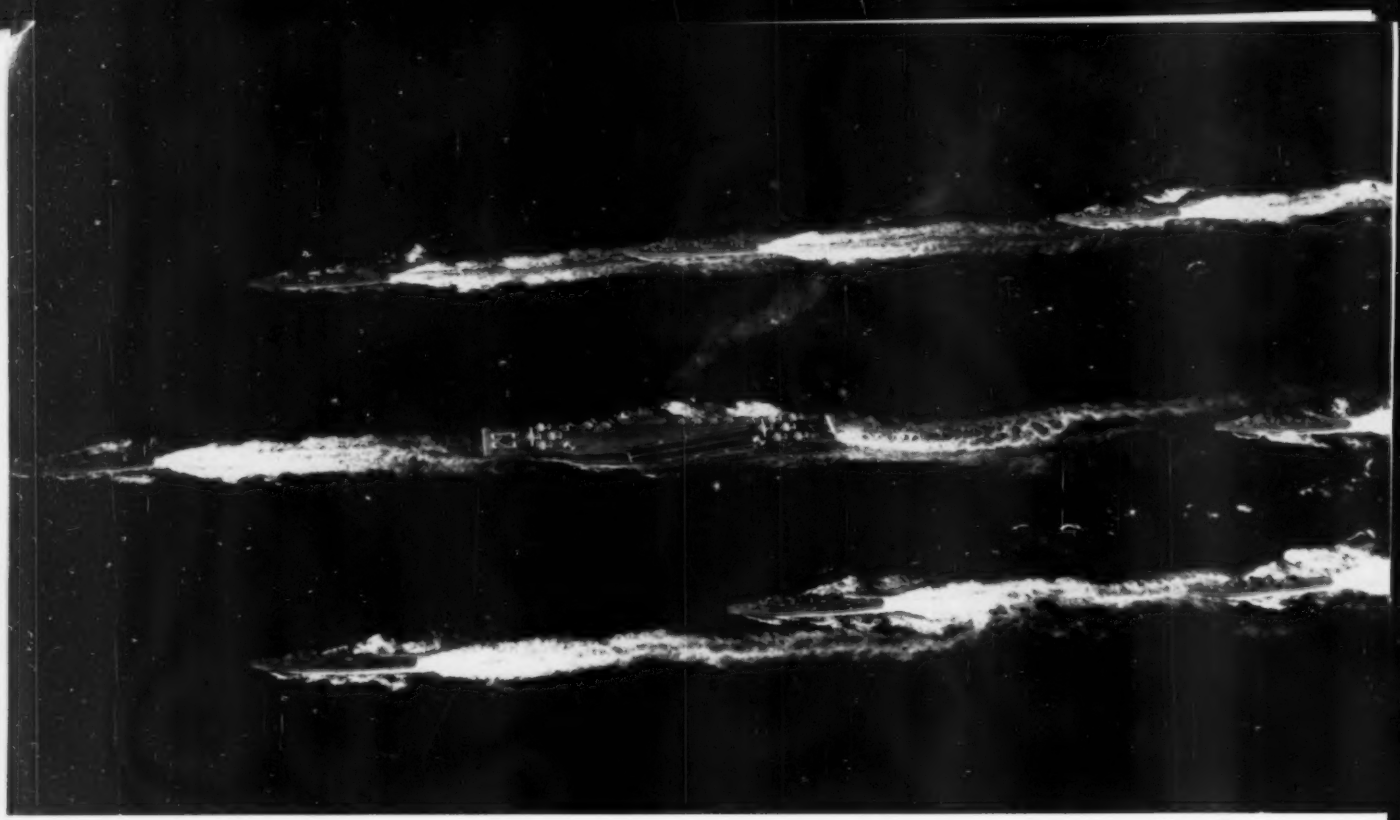
Events since 1945 clearly show that the amphibious operation is the most useful, versatile, and economical of any form of military operation used by the United States.

THE amphibious operation generates enormous power—at the same time it can be responsive in exact amounts to the degree of force or destruction which the United States wishes to employ. It is completely flexible in its employment; it suffers no restrictions as long as the target can be reached by the ocean.

Born on the high seas, it is affected least by the restrictions of national sovereignty. It does not require the presence of a friendly reception, or airfield, for its troops to be landed. It does not require dependence on a rigid line of communications with an expensively maintained prepositioned logistical build-up—it carries its logistical build-up with it.

It has the great advantage, since it can be maintained from the sea, that it does not require a large logistical installation on shore.

This operation, which is so useful, so versatile, and so economical, is one which the Navy and the Marine Corps are prepared to perform at any time for the United States.



(*Navy photo*)

Weapons for the Fleet

Rear Adm. Paul D. Stroop

THERE are two vital topics which should be given serious attention at this time. The first is the spiraling upward cost of weapons and weapons systems, and the second deals with the relations between the armed services in the area of weapons development.

With regard to the first topic—the spiraling upward trend in weapons costs—I must say most seriously and most emphatically that this must be halted, and I make the most serious appeal to the members of the American Ordnance Association to advise us and to help us in our efforts to reduce the cost of weapons and weapons systems.

Speaking specifically about the upward trend in the cost of Navy aircraft, which became my responsibility with the amalgamation of the Bureau of Ordnance and the Bureau of Aeronautics, during World War II our cost per pound of an aircraft structure averaged only $9. This cost has gone upward year by year until in the 1961 budget our costs were estimated at $110 a pound—a most alarming trend and a most alarming figure.

Admiral Stroop is Chief of the Bureau of Naval Weapons, Washington, D. C.

Fortunately, we appear to have leveled off and even to have dropped back in so far as the procurement of aircraft for the Navy is concerned, and our 1962 budget estimates are reflecting this trend. Today the Navy places great emphasis on cost reduction—value engineering, "more bang for the buck," or whatever you want to call it.

The Congress, and the congressional committees, particularly the appropriations committees, have shown great interest both last year and this year in this subject. For example, the House Appropriations Subcommittee last year took positive action in drafting the law covering the annual appropriation. Specifically, last year the Navy's appropriation for the procurement of aircraft and missiles for fiscal year 1961 was $2 billion.

The program as requested by the Navy for aircraft and missiles was approved by the committee and subsequently by the Congress. We were authorized to buy the numbers of aircraft and missiles as requested, but the Congress gave us an arbitrary three per cent cut across the board—saying, in effect, that you can buy all these aircraft and all these missiles that you want, but you must get them at three per cent less. This 3 per cent on a $2 billion-plus appropriation amounts to $66 million—and I have been sweating it out ever

since trying to buy the program for this reduced amount!

HOW are we doing? All the aircraft and all the missiles in the 1961 program are on contract, but I am still concerned with our ability to procure all the very necessary support equipments—the spare parts, the contractor field services—all of which will be needed to support these aircraft and missiles.

The next question then is, What steps have we taken in the Navy during the past year to reduce costs? We have instituted a very serious campaign to make all our people in the Navy cost-conscious. This includes engineers, administrators, contracting personnel, and inspectors. This campaign has extended, too, to our contractors, and all the major contractors have received personal letters from me on this subject.

The campaign for cost reduction has received the full encouragement and cooperation of our Navy Secretaries and of the majority of our contractors.

In our letters and conferences we have outlined steps to be taken and have invited all to participate actively in the program. Our contractors have been invited to question requirements; that is, are we asking our equipment to do too much? We also have asked contractors to question the specifications—are they too tight? We have asked them to question the test procedures—do we demand too many and too stringent tests? We have tried to schedule contractors for longer production runs, and if we can't do this directly, then by means of add-ons or options on current contracts.

Two years ago at the A.O.A. meeting in New York City, Lieut. Gen. Robert F. Sink, Commanding General of the XVI Army Corps, recommended to Lieut. Gen. John H. Hinrichs, Chief of Army Ordnance, that the Ordnance Corps Institute a "Kiss Program"—the initials standing for "Keep it simple, stupid!"

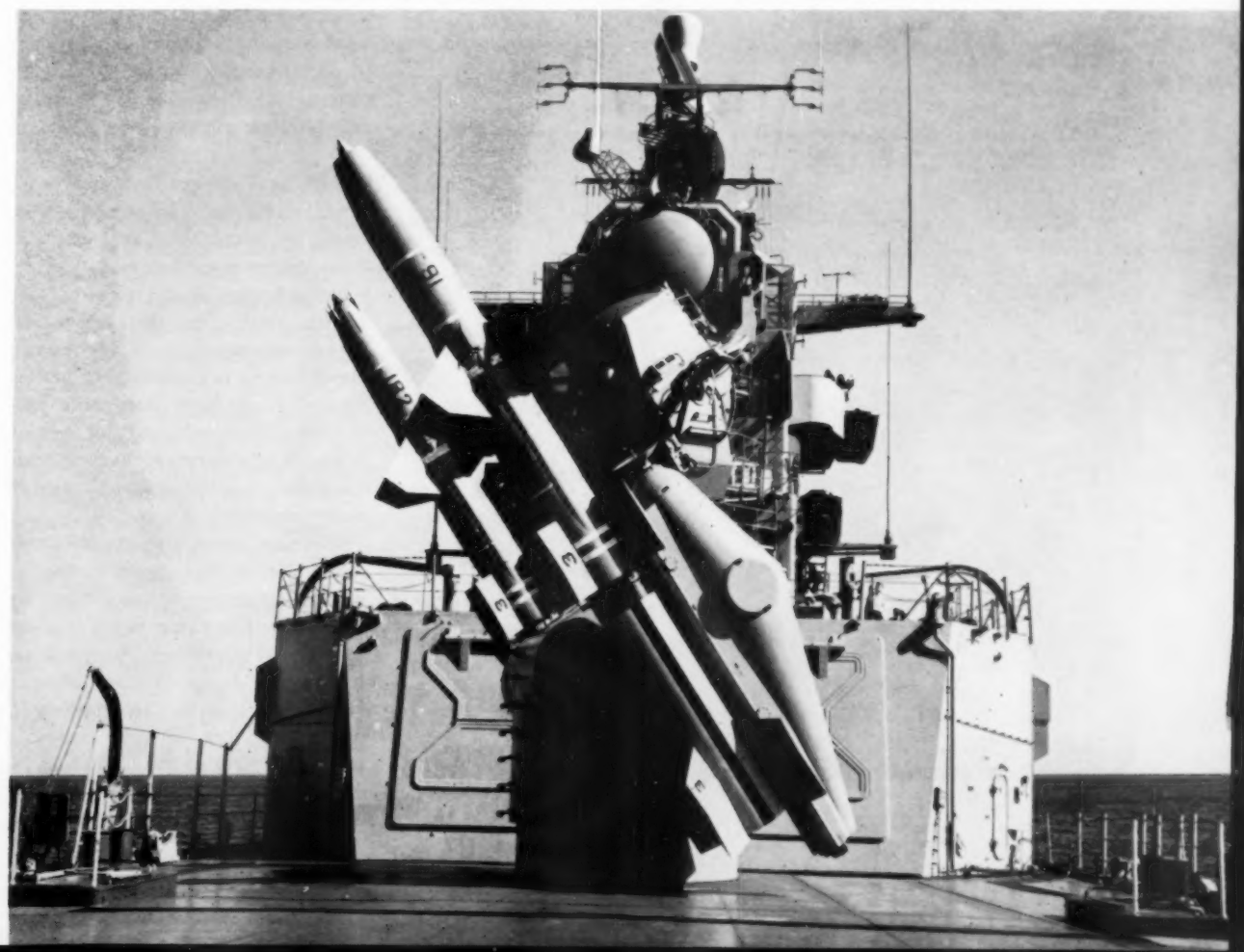
We have a "Kiss Program" in the Navy, too, and we are making very serious efforts to have fewer technical and engineering changes, particularly in the production models. I have instituted technical discipline among the engineers and field stations as a measure to reduce such changes.

We are inquiring, too, into the possibility of reducing the numbers of drawings required to be delivered with our production equipment, and, finally, we are trying to make better contracts which will provide incentives and rewards to the contractor for his successful cost-reduction efforts. Specifically, he will earn a higher profit if he can reduce the cost to the Navy for the end item.

THE results have been encouraging. I can't promise that I will be able to save the full $66 million. But, even at this early date, we can report some significant progress.

As I stated earlier, the cost of aircraft per pound is down a little in our 1962 budget, and while I have used the aircraft program for illustration, my

An Asroc antisubmarine rocket battery ready for action aboard the U.S.S. MAHAN (Navy photo).



comments apply to all our programs. We must be able to buy more military hardware for our money. In all seriousness, the security of the United States and the security of the free world depend upon our success in this endeavor.

AS for my second topic—cooperation among the armed services in weapons development—I can report that it is very good—even outstanding. Historically, this was noted by the late first Secretary of Defense, James Forrestal, when he said:

"Unification had its practical beginnings in the relationship between Army and Navy Ordnance, particularly the personal relationship between Admiral Blandy and Admiral Hussey of the Navy and General Campbell and his successor, General Hughes, of the Army. These men showed that sincerity of purpose and honest effort and cooperation could pay high dividends."

I realize that it is fashionable and newsworthy to report divergent opinions—so-called interservice squabbles—but the many examples of close service cooperation do not make much news.

I want to say, too, that the American Ordnance Association is a good influence—a wonderful catalyst for the services in aiding cooperation and understanding. At your technical meetings and at your annual meetings you bring all three services together. Your headquarters staff in Washington and many others all directly and indirectly help to improve and to perfect this cooperation.

"We are making very serious efforts to have fewer technical and engineering changes, particularly in the production models. I have instituted technical discipline among the engineers and field stations as a measure to reduce such changes."

I would like to urge all members of the American Ordnance Association to realize that we do have mutual interservice development and procurement programs in the weapons areas and to examine any program or hardware item with which they are concerned for possible interservice use. The examples of interservice cooperation are too many and too varied for even a partial recital of them, and I will mention only a few.

Two years ago in the Navy we had a small but very serious problem in the production of a propulsion powder grain for the Sidewinder missile. We had been procuring our bulk sheet powder—as we usually do—from Army sources and had been advised by the Army that our original source was to be discontinued and that we should go to a replacement source. This we did, only to find suddenly that the new grain would not quite meet requirements. More development time was needed.

It appeared as a consequence that our production line for finished Sidewinders would be shut down—a costly and a serious setback, as Air Force, Navy, and allied forces urgently required these missiles.

I called General Hinrichs on the telephone. There was no argument, just complete and full cooperation. He started up the sheet propellant line over the weekend, and on Monday we were again in business at the Indian Head Propellant Plant fabricating the grains for delivery, and the final assembly line continued uninterrupted. All of this was accomplished with a single telephone call to General Hinrichs.

I can report, too, that we have the same excellent, effective arrangements with the Air Force. I enjoy a close personal working relationship with my friend, General Anderson at Wright-Patterson Air Force Base. We work together with a minimum of red tape.

A Talos supersonic surface-to-air missile is shown below being fired from its special launcher aboard the guided-missile cruiser GALVESTON (Navy photo).

THE list of equipment items, goods, and services provided on a joint basis among the Army, Navy, and Air Force is too long to repeat here but a few are low-drag bombs, aircraft rockets, Sidewinder missiles, and the joint use of Government-owned plants. The Army's Hawk missile is also used by the Marines. We also have interservice procurement in aircraft, and this area of cooperation is certain to increase with identical or closely related models jointly procured.

We have many examples of cross-servicing in contract administration and in carrying out inspection services for each other. The simple fact is that the armed services are cooperative and do, in fact, have an excellent and effective program of weapons development and procurement that will help assure the effective defense of the United States.

Proving Ground of Policy

The evaluation and acceptance of national strategy should never be finalized without close collaboration between civilian authority and the military services so that mutual confidence may be established

Maj. George Fielding Eliot

AT the various proving grounds where our new weapons are tested the basic operating principle is expressed by the very name of the establishment. A proving ground is a place where the product of theory and experiment is subjected to physical *proof*. It stands or falls on the result. Only the proven concept wins acceptance. Whatever fails to prove itself goes to the scrap heap—or back to the drawing board.

The proving ground is thus a vital element in the decision-making processes of our military technology. Weapons and their components do not await the verdict of the battlefield—the process of trial and error and try again is applied to them before the lives of men and perhaps the fate of the Nation come to depend on their reliability.

Not long ago a wise friend who has thought deeply on such matters said to this writer:

"If only there could be a proving ground for new ideas in the decision-making processes of our higher strategy and of the national policy which it serves! If only we did not have to test these ideas by trial and error in actual practice—and suffer the consequences of error when it occurs.

"The uncertainties of this procedure lead to hesitation when boldness is demanded, or to hasty attempts to compensate for error which haven't been thought out. They lead to brave words which are not followed through; they lead to overemphasis on the consequences of failure and a glossing over of the consequences of inaction.

"If only we could have a proving ground where we could get the bugs out of these concepts before we have to try them—with the whole world, including our enemies, looking on!"

If we examine this notion carefully we may find that a proving ground for concepts of policy and high strategy isn't quite as fantastic as it appears.

Proving grounds depend primarily on experience. In any given test the combined experience of the officers, engineers, and technicians who conduct the operation is guided and helped by the accumulated experience of their predecessors, boiled down, analyzed, and made available in the manuals, directives, and regulations which govern the activities of their unit.

Beyond that, they are likewise aided by the analyzed combat experience of the fighting arms as to the performance in the field of weapons or equipment of like character to that being tested, or which may be replaced by the new item if it works.

The writer recalls having occasion to write an article during the Korean war about the performance of our infantry weapons. Upon making inquiries through the usual Ordnance channels, with some idea that Aberdeen Proving Ground might provide most of the answers, it turned out that Aberdeen was only part of the story.

There was a regular system by which, periodically, combat leaders fresh from Korea were brought to the Infantry School at Fort Benning to provide a constant flow of current experience in the performance under field conditions of all types of infantry armament and of supporting arms as well.

THIS experience was churned into the mill at Benning, and there was the closest sort of information exchange between Benning and Aberdeen, so that a test crew at Aberdeen would have before them the school-evaluated opinion of, say, a squad leader just back from the front as to the performance of his squad's weapons at below-zero temperatures.

The new small-arms now being produced for our services are in large part the product of this Infantry-Ordnance (and, of course, industry) teamwork. Not the least important part of proving these weapons was the comparative evaluation of older weapons on the battlefields of Korea. It is the sum total of relevant experience which counts.

Now there also exists a vast and ever-growing reservoir of human experience,

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extending back through the ages of recorded history, for the guidance of those who from time to time become responsible for the conduct of national policy and high strategy. It may be thought that there is a great difference between this kind of decision making, which is essentially political, and the technological decision making process in which the proving ground is the key element.

The latter task is in the hands of fully seasoned professionals, while the former must often be undertaken by relatively inexperienced men, at the top level at least. Where are these leaders to find a proving ground to try out the policy concepts which occur to, or are presented to them?

Might not the search for such a proving ground begin at the same place that the military proving ground begins each test series—with the question, "What is this thing intended to do?" The question of whether it will work can logically be asked only after that first key question has been answered.

Going back to our infantry small-arms tests, what is the basic requirement of any infantry weapon? Simply this—that in action it shall prove itself to deserve the confidence of Private X. Upon that cornerstone of user confidence the whole concept of infantry armament depends. How the weapon behaves in the hands of Private X under the stresses, the discomforts, and the perils of the battlefield is what matters.

IF Private X panics or goofs off, no weapon will do him much good, but the average American soldier can face up to quite a lot of danger and misery as long as he has confidence in his weapons and his comrades. While he belongs, *in his own mind*, to a fighting outfit that is armed to win and that is going to win, he is likely to keep on trying to win.

This mental and psychological image of a fighting and winning outfit will, in Private X's conception, hardly extend beyond his own company—certainly not beyond his battalion or battle group. His evaluation of his company officers and NCO's will have something to do with his confidence in that image; so will his evaluation of such supporting arms as come within his own experience. The training of combat leaders and the design of supporting weapons both are aimed at the ultimate target—the confidence of the soldier whose fighting spirit is the foundation of success in battle.

In the Infantry-Ordnance evaluation described above, one notable feature was the searching and minute cross-examination of noncommissioned officers as to the views of individual privates about all items of armament which could affect the soldier's chances of success and survival.

It was clearly evident that the confidence of Private X in the arms supplied by his country was considered a basic element in building up his confidence in himself and in the combination of men, weapons, and spirit which make up his image of the fighting unit to which he belongs.

To do this, of course, the arms must deliver A-1 performance under field conditions, in all sorts of terrain, weather, and stress. The leadership must likewise be of such quality that the combination of men and weapons can be so employed as to maintain a high level of fighting spirit.

Continuous, unbroken success for every unit is not to be expected; fighting spirit is not lost by occasional defeat, but it can be lost by consistent mishandling of units, and it can be lost by inaction or irresolution or by a constant shifting of tempo which informs the soldier that his superiors haven't made up their minds what they want to do.

Private X's personal image of his outfit may be satisfactory to him, and yet he may become disheartened if he realizes that his outfit is not being given a chance to do its best because somebody higher up, at division or corps or army level, is hesitant when boldness is demanded, is mentally overemphasizing the consequences of failure, and glossing over the consequences of inaction.

Private X may not be qualified for the General Staff, but nobody is quicker to detect vacillation in the high command than an infantry soldier who is suffering the consequences of that vacillation. Instinctively Private X understands that this, in the end, means that he and his outfit are likely to be sacrificed in a desperate last-minute stand against a foe advancing in the full confidence that victory is in sight.

Now Private X of the —th U. S. Infantry was once plain Joe X of Baltimore or Kansas City or Steamboat Springs, Colo. He is a microcosm of the great American community which he serves. Surely, when we come to consider how to prove and evaluate concepts of national policy or high strategy, we can start at the same place that we start with the proving and evaluation of weapons—with the question: "What is this thing meant to accomplish?"

THE first requirement is, just as surely, to gain and retain the confidence of all the Joe X's and all the Mrs. and Miss X's in the Nation—or as many of them as possible. Just as Private X's image of fighting power does not extend much beyond the confines of his company, and is a thing sensed rather than a thing thought out in analytical detail beyond the bounds of his personal experience, so Joe X's image of national power and his confidence in it does not extend to any informed analysis of the decision-making pocesses by which the national power is used or misused or not used at all.

Private X and Joe X have this in common—they want their side to win. They can understand occasional defeat; they cannot understand or at least they cannot tolerate continual timidity, hesitation, brave words which are eaten when challenged, called bluffs, the abandonment of initiative to the enemy. They would both agree instinctively with a sentence from the old Infantry Drill Regulations:

"Any plan, even though defective in some particulars, if boldly and resolutely carried through to a decision, is better than the hesitating search for the ideal."

What they want is an American power-image in which they can put their trust and which can and clearly does command the enemy's respect. If

there is sometimes a local defeat in seeking these ends, that can be accepted—provided that now and then there is a local success as a counterbalance. Not to try to win is the unforgivable sin, to their way of thinking.

They are very quick to appreciate the effect on others of not trying to win. It is this that troubled many Americans, in and out of uniform, about the defeat of the ill-starred "invasion" of Cuba. "We shouldn't have let it start unless we meant to see it through," was the verdict of taxi drivers, salesgirls, barbers, and elevator operators for days afterward.

IT is instructive to observe that clear back in the formative days of the French Republic the final decision of the Foreign Minister Vergennes to conclude an alliance with the United States was, as he told Benjamin Franklin, more influenced by Washington's attack on Howe's army at Germantown, which was a drawn battle, than by the decisive victory of Saratoga.

What impressed the French statesman was that Washington, so soon after his defeat on the Brandywine, had not hesitated to resume the offensive against Howe's superior force and that our troops had given so good an account of themselves in the fighting.

Thus in seeking a proving ground for our concepts of policy and strategy, we may find a useful standard of evaluation in asking this one primary question: "Will this idea, if carried out, increase the confidence of the American people in themselves, their leadership, and the eventual triumph of their cause?" Immediately afterward might come a second question:

"Would it be better to try this and fail, or to look around for something less risky and meanwhile do nothing?" Such an approach involves, of course, a weighing of risk against advantage—a common feature of all planning which has a military aspect (and indeed of much totally nonmilitary planning).

It is suggested that the risks of an active policy, imbued by the spirit of trying to win, will be far more readily accepted by Americans and will breed a far more rugged spirit of confidence in their minds and hearts than the risks of waiting to see what the enemy is going to do next.

Editorial comment in the May-June issue of ORDNANCE quotes Lieut. Gen. James M. Gavin to this effect: "We must respond rapidly . . . with significantly greater mobility than anything we have thought of in the past, for it is in mobility that innovation will be found. Tactical and strategical innovation is as essential to survival as the hardware of combat itself. . . . Sooner or later we must face up to this fact: we must be *for* something more than merely 'against Communism,' and our weapons systems must reflect what we are for."

In these considerations lies the primary test for our policies and the strategy by which those policies must succeed or fail. Here is the first step in our proving-ground technique for high-level concepts of policy and strategy. For the second step—evaluation—we can hardly have a better example than the Infantry-Ordnance teamwork by which our infantry weapons were proved and evaluated. There must continue to be close, regular, and organized collaboration between the evaluators of policy and those who must carry it out.

We do not need *quick* decisions as much as thoroughly weighed and scrutinized decisions. Under our Constitution, high-level decision is the province of responsible civilian authority, but it is the duty of responsible civilian authority to give full weight to professional advice in these matters—especially professional *military* advice. The machinery for this purpose exists, though it is complicated machinery which requires skillful handling.

During the last year of the Eisenhower Administration, the machinery was being skillfully operated by Secretary of Defense Gates through the relatively simple procedure of regular personal attendance of the Secretary at the meetings of the Joint Chiefs of Staff. While Secretary McNamara has continued this procedure, he has diluted the professional advice of his duly established military counsellors by seeking additional advice from civilian "operations analysts" and others who lack the requisite experience.

To what extent this dilution, and the concomitant emphasis of the New Frontier on "quick decisions," was responsible for the disaster in Cuba is not clear at this writing. What is clear is the need for reestablishing the time-tried relationship between civilian decision and military advice in the formulation of policy and strategy.

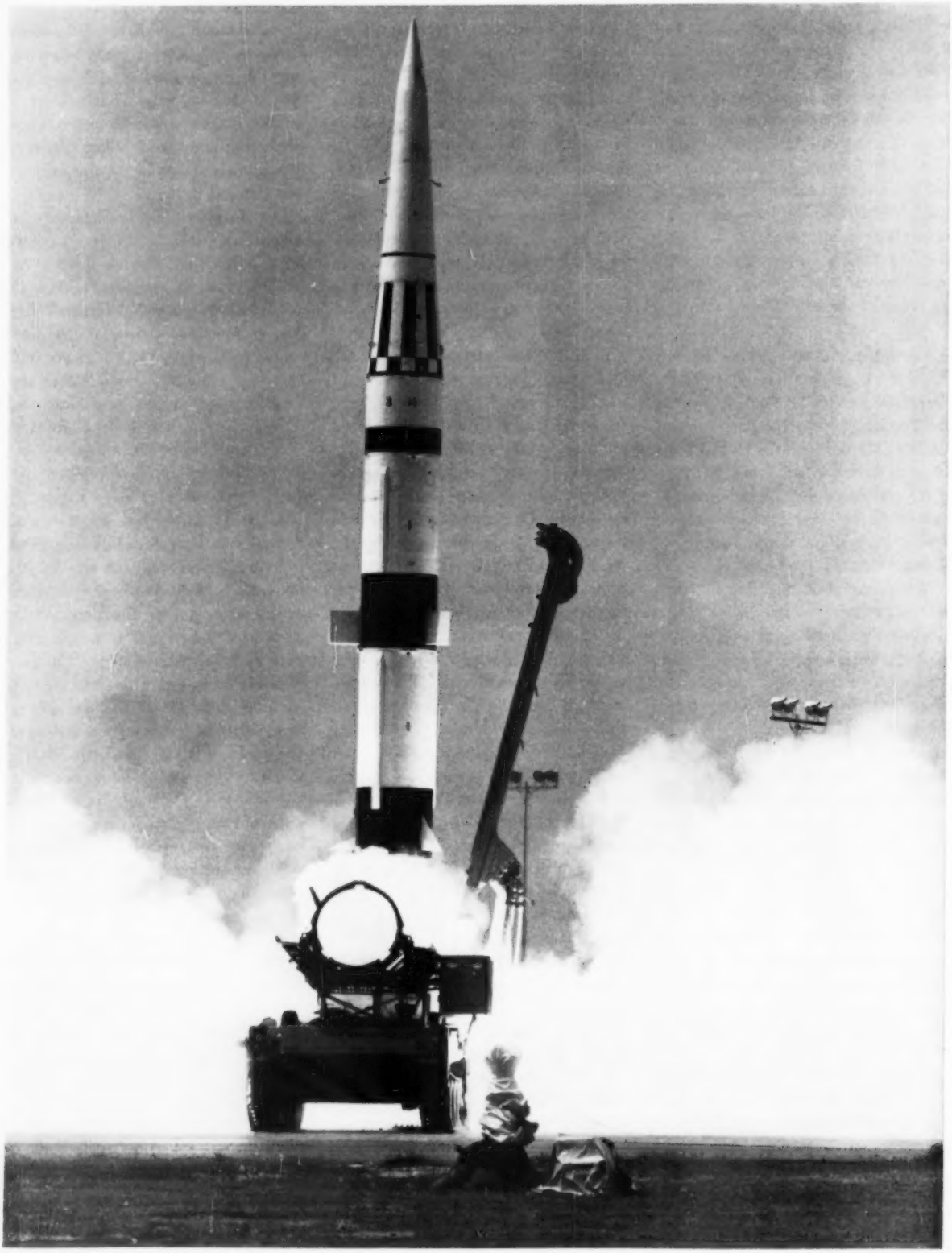
Past President Louis Polk of the American Ordnance Association points out that our final reliance must be in the understanding and confidence of the American people. They will give their confidence to political leaders who appear to deserve that confidence, but they give enduring confidence to the armed services which have been part of our history for generations and which have proved their right to possess the people's confidence.

IT should not escape attention that Congress has persistently demanded from the Chiefs of Staff, collectively and individually, their opinions of the military budget and of the proposals of even General Eisenhower in matters of military policy and strategy. The nonmilitary leadership of the new Administration will do well to take note of this recurrent tendency—it reflects a congressional understanding of the sources of grass-roots confidence.

Just as the Ordnance-Industry segment of our armaments evaluation and acceptance system would not dream of finalizing its work without the close collaboration of the combatant arms, so the evaluation and acceptance of concepts of policy and strategy should never be finalized without close collaboration between civilian authority and military advice. Decisions which contain too great an element of computer-produced "analysis" to the neglect of the intensely human factors which are woven into the warp and woof of military judgment can prove fatally defective when put to the test.

What we need above all is to escape from our current miasma of frustration and failure—to reconvince both Private X and Joe X that they do belong to a fighting outfit that is armed to win—and is going to win.

New Look in Pershing



The latest configuration of the Army's surface-to-surface Pershing ballistic missile is shown above taking off on a test flight from its mobile erector-launcher. The new Pershing has improved motors in both stages, and the nose cone, produced by the Martin Company, is made by simple and inexpensive techniques. Test was made at Cape Canaveral, Fla.

Destroy That Satellite!

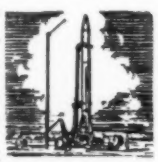
The advent of orbiting space vehicles with their potential for reconnaissance and attack has made necessary research to decide on the feasibility of space-borne defense systems against them

Vern Haugland

SOMEWHERE behind the Iron Curtain a powerful Russian rocket arched up into the sky last February 12th and placed a new satellite, Sputnik VIII, into orbit around the earth. Variously described as a mother satellite or a space platform, the Sputnik went into what is known as a parking orbit—an orbit from which, at the desired time and place, a 1,418-pound interplanetary vehicle separated from the 7-ton Sputnik and raced off along a course that might take it past Venus and into orbit around the sun.

Western scientists concluded that this was hardly a pickaback satellite launching itself from a space platform; rather, the final stage of the Sputnik booster rocket apparently had been ignited, after the required waiting period in orbit, to accelerate the instrumented payload to the velocity it needed to escape the earth's gravitational field.

The military significance of the parking-orbit technique was noted widely and immediately. If the Reds could orbit a satellite around the earth and use it to send an object spaceward on demand, certainly they could fire also in the opposite direction, back toward earth. In effect, here was a prototype of the space bomber or missile-launching platform of tomorrow. Here was a clue to the weaponry of a future war that might be waged miles above the earth.



Author of the book, "The AAF against Japan," Mr. Haugland also is the well-known Washington aviation correspondent for the Associated Press.

But does the average citizen of the United States appreciate and understand, yet, the military meanings of space? Many defense planners are becoming increasingly concerned over the predominance given the civilian, scientific, and peaceful missions of space—an emphasis that has prevailed since before the Russians launched their first Sputnik on October 4, 1957.

They point out that the United States, in accordance with its peaceful traditions and its support of international cooperation within and outside the United Nations, was a primary force in the space programs of the International Geophysical Year.

The civilian and scientific character of the U. S. space program took shape at the very start. There was a popular theory that space research was so costly that no nation could go it alone; that here might be the way to world peace because energies formerly devoted to war could now be channeled into programs for reaching the moon, the planets, the sun—even other solar systems.

The National Aeronautics and Space Administration came into being and was given prime responsibility for space programs. Its administrators were civilians, and civilian scientists staffed its bureaus. The Nation's relatively minor military interests in space were relegated to the Advanced Research Projects Agency of the Defense Department.

The voice of the civilian scientist, such as Dr. William H. Pickering, head of the Jet Propulsion Laboratory at California Institute of Technology, was loud in the land. Dr. Pickering said that the existence of separate civil and military space programs meant unnecessary duplication of effort and undue competition for dollars, scientific capability, and technical facilities.

ARGUING that "most of the space weapon programs, if they are going to be weapon systems, are a long way off," he urged that NASA be given control over all space programs, including the Midas and Samos satellite projects of the Air Force. This type of thinking was in accord with the policy of the Eisenhower Administration that space would be explored primarily for peaceful purposes and that the military role in space would be relatively slight.

Last October the Air Research and Development Command appointed a 15-man committee of prominent scientists and industrial experts, headed by Trevor Gardner, to review Air Force space activities and to study "the full range of existing and potential Air Force space developments."

At the same time the Air Force

Midas II, shown aboard an Atlas-Agena launch vehicle, was the first test of the new Air Force surveillance satellite system concept.

started pushing more aggressively than ever before, in the Congress and in public statements generally, for a broadened space role and for authority to undertake expedited development of military space systems.

The leading Air Force spokesman in this effort has been Lieut. Gen. B. A. Schriever, ARDC Commander. As Commander of the Air Force Ballistic Missile Division from 1954 to 1959, General Schriever was concerned not only with development of the Nation's ICBM forces but also with analysis of Russian developments in missiles.

AS long ago as February 1957—before any ballistic missiles of intercontinental range had been launched and before any satellite had been sent into orbit—General Schriever pointed out that it was possible to develop systems for operations in space and that more than ninety per cent of the equipment required was already under development.

"I am concerned that the importance of satellites and other space systems as essential elements of our military strength is not fully appreciated," he said recently.

"I am convinced that the importance of space to our national survival is not yet fully understood. I am not convinced that we have done everything possible militarily in space. In our concern for peace we may not have exploited fully all avenues leading toward the preservation of peace.

"I am concerned with the feeling among many Americans that our civilian space program represents our national space program. It is a major portion and an indispensable portion of our national program but it is not, and it cannot be our total space program....

"Our military requirements for space will not be completely satisfied by the developments under way or planned in our civilian programs. The military and civilian missions in space do not merge into the single image.

"There is a clear divergence which becomes immediately apparent when the nature of the military and civilian roles are examined and compared. The basic divergence between Defense and the space agency is simply this: The primary responsibility of the Department of Defense in the exploitation of space is the security and survival of the United States. The primary purpose of NASA is the investigation of space for scientific and other peaceful purposes.

"The basic reason that the divergence between our military and civilian programs has not been apparent thus far is that it has been necessary to use essentially the same and only resources—and by that I mean facilities and hardware—which have been available largely from ballistic-missile programs during the past several years.

"It seems to me a matter of the highest urgency that this Nation exploit to the fullest the exciting and challenging possibilities which space offers. This is of primary concern to the military. Space offers a natural medium for increased effectiveness in our defense. This is particularly true in the areas of warning, communications, and observation."

A MID-January report by the House Space Committee declared that the lack of a clear statement of peaceful and military national objectives has for several years resulted in an unhealthy competitive atmosphere. At about the same time a special committee appointed by President Kennedy called for a review of the national space program and a redefinition of objectives, particularly with regard to the rocket booster program, manned space flight, and the military uses of space.

The Committee's recommendations bore special weight because its chairman, Jerome Wiesner, was appointed President Kennedy's Special Assistant for Science and Technology. The report itself was received as an outline of the new Administration's planning for a general revamping of the U. S. space program.

GEN. Laurence S. Kuter, Commander, North American Air Defense Command, has warned that "in aerospace defense we stand at the edge of the 'sixties, looking forward to a tomorrow that holds the certainty of an intercontinental ballistic missile threat and, not far distant, the requirement to defend against hostile satellites."

Lieut. Gen. Roscoe C. Wilson, Air Force Deputy Chief of Staff for Development, has pointed out that although the Army Nike Zeus program would aid defense through the interception of a missile in the final stage of its flight, the most effective time to intercept an ICBM is during its boost phase while it is still being propelled by its missile engines.

"Such a boost-phase interception system would have to be based in space where it could attack an enemy ICBM on its rise from the atmosphere," he says. "At this stage the ICBM's exhaust plume makes it an excellent infrared target, and the missile is also in a 'soft' and vulnerable condition."

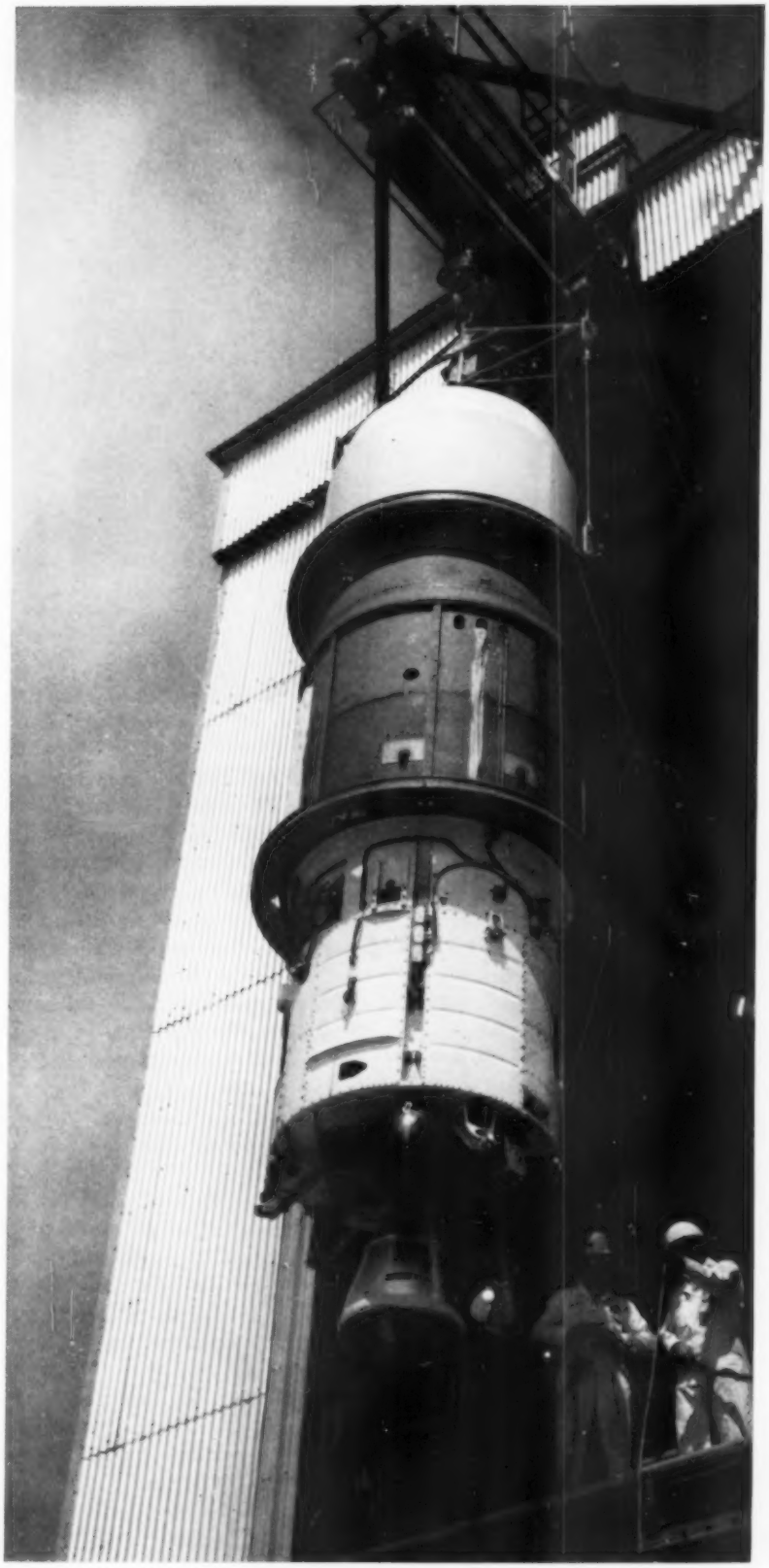
THE Air Force and Advanced Research Projects Agency are conducting research to establish the feasibility of a specific space-borne defense system. General Wilson says extensive studies by the Air Force, industry, and other technical groups indicate that boost-phase interception is practical—but some years in the future.

"We feel assured that we can achieve such a system by the late 'sixties," he says.

The Air Force has made impressive strides in space with its programs for the development of the Midas early-warning satellite using an infrared scanner to detect the exhaust flames of an ICBM seconds after launching, with the Samos photographic reconnaissance satellite, and with the successful air-catch recovery of capsules released from Discoverer satellites.

Through a network of observation facilities and the National Space Surveillance and Control Center at Cambridge, Mass., a capability is being developed to keep close track of the man-made objects in orbit.

"We do not, however, have a capability of determining at close range the nature or intentions of objects in orbit, and future circumstances may require that we have the ability to do so," says General Wilson. "For this reason we have a research and development program known as Saint, which looks toward a vehicle which could rendezvous in space with unknown orbiting objects for identification purposes."



The Agena A vehicle was the first satellite in the Air Force Samos project to determine the engineering feasibility of obtaining observations and scientific data from an orbiting vehicle (all Air Force photos).

Preliminary studies of the Saint (the name stands for "satellite intercept") were conducted by Radio Corporation of America and Space Technology Laboratories. Last fall secret briefings for industry were conducted separately on the satellite launching vehicle and its payload. Late in November, RCA was chosen to develop both the final stage of the launching vehicle and the inspection payload.

Aerospace Corporation, a newly organized Air Force technical management firm, was given responsibility for Saint's systems engineering and technical direction as its first major program.

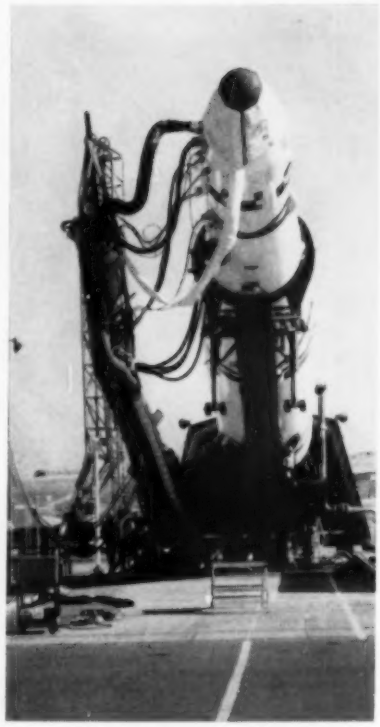
THERE was no official disclosure of the project's cost, but initial funding was believed to be $50 million to $60 million for eight vehicles. RCA's share of the initial program would be about half of the total.

"The present program is a technical exploration," the Air Force announcement said. "If successful, it could lead to a rendezvous system with unknown satellites in orbit for identification purposes."

The Saint launching vehicle will be the Convair Atlas ICBM topped by the 25-foot, 15,500-pound Lockheed Agena B upper stage. The Agena has been the work horse of the Discoverer series, and the Atlas-Agena B combination also is the boost vehicle for the Midas and Samos polar-orbit satellites.

The first of the Saint test satellites will weigh about 2,200 pounds each. Test launches are expected to start late next year at Cape Canaveral, Fla. For testing purposes a balloon-type satellite or similar form of target will be launched into orbit at an altitude of about 450 miles.

After the balloon has completed one or more passes around the earth, the Saint vehicle will be so launched that it goes into orbit above and ahead of the "unidentified and possibly hostile" target satellite. When the Saint vehicle is within fifty miles of the target its homing radar will lock onto the suspect, and reverse-thrust rockets will slow the Saint just enough to permit it to descend and approach the intruder. Television equipment will relay



Discoverer VII is prepared for launch.

to ground stations the information required to identify the satellite.

Operational models of Saint may be twice as heavy as the initial experimental designs. Plans include infrared and other inspection devices to sense whether the target satellite contains nuclear arms, electronic equipment, or other materials. Obviously, the same satellite that identifies an enemy craft could be equipped also to destroy it. However, General Schriever says emphatically that Saint satellite systems are not in any sense offensive weapons.

"I have in mind not only the fact that our use of them will be solely to deter aggression, but also the fact that they are entirely passive in character," he says. "They carry no armament and represent no threat to any other nation."

Nevertheless, the Air Force is actively seeking broader responsibility in the satellite field and changes in the national space policy to permit the development of offensive as well as defensive space vehicles. Basic in this new outlook is a requirement that the Air Force be allowed to develop large booster rockets and be granted authority for man-in-space projects, two important fields in which NASA currently rules exclusively.

Concerned over launching costs—estimated at $9,100,000 each for the forthcoming Centaur vehicle and $17,300,000 for Saturn—the Air Force has plans for development of less expensive boosters, and also for boosters that can be recovered and reused.

The Air Force and ARPA have under way a large number of study contracts in the area of antisatellite satellites and satellite-borne anti-ICBM systems. One much-discussed concept, studied by Convair, is known as Spad, (for Satellite Protection for Area Defense). It calls for placing 2,000 to 3,000 satellites, each equipped with as many as 6 missiles, in random orbits some 230 miles above the earth. Sensors in the satellites would detect ICBM's at the moment of launch. The Spad satellites would quickly plot an ICBM's course and fire missiles to destroy it.

Another concept, proposed by Thompson Ramo Wooldridge Inc., and called the Random Barrage System, would employ up to 100,000 satellites, each capable of making the interception and kill itself rather than discharging a missile. Both satellite systems would be expensive. Cost estimates for each program range up to $15 billion.

RYAN Electronics has proposed a force of twelve squadrons of twelve orbiting patrol craft—controllable anti-ICBM vehicles in specific circular orbits to provide continuous surveillance of the earth. Another ARPA study, called Bambi, would provide a satellite capable of launching missiles against ICBM's.

For defense against nuclear-armed satellites, Hughes Aircraft Company and Lockheed Aircraft Corporation, have modified a proposal for a space ferry system for maintenance and repair of manned space stations into a design that could detect, track, intercept, and destroy hostile space bodies.

Another study concept calls for the use of missile-armed satellites weighing 6,000 pounds, in 115-mile-high orbits, to serve as "recallable" ICBM's. Should the attack alarm prove false after the

missile had left the satellite, there would be no final attack signal. The missile would divert itself instead from the original target into a preselected remote area where it could impact without inflicting damage.

Other proposals would employ satellites as strategic bombers, orbiting harmlessly until they are called into action because of enemy aggression. A "low-altitude" bomber satellite would orbit at altitudes up to 23,000 miles, and "high-altitude" vehicles would maintain orbits farther out in space.

Many programs call for manned satellites. There are also proposals for development of the Dyna-Soar hypersonic space glider concept in the weapons field, and for use of the so-called space plane—a winged, manned vehicle which would go from the earth into orbit and return under its own power —either as an offensive craft or as a military command post in space.

The one-stage-to-orbit space plane would attain the great power it needs partly by using the oxygen from the air as it rises through the atmosphere, and by using winged surfaces for lift when required.

ONE means under discussion for destroying or rendering reconnaissance or offensive satellites ineffective is to spray sand, pebbles, silver, mercury, destructive chemicals—or even ice particles—into their orbital paths. Even tiny particles, moving at 4½ miles a second, can inflict damage upon impact with a body moving at equal orbital speed in the opposite direction.

Joseph V. Charyk, Air Force Under Secretary for Research and Development, told the House Space Committee the Air Force also is considering the idea of imposing screens of carbon between targets and infrared air-to-air missiles, to confuse their guidance systems. Concentrated heat, nuclear radiation, magnetic or electric fields, or beams of protons or electrons also are possible means of putting hostile satellites out of commission.

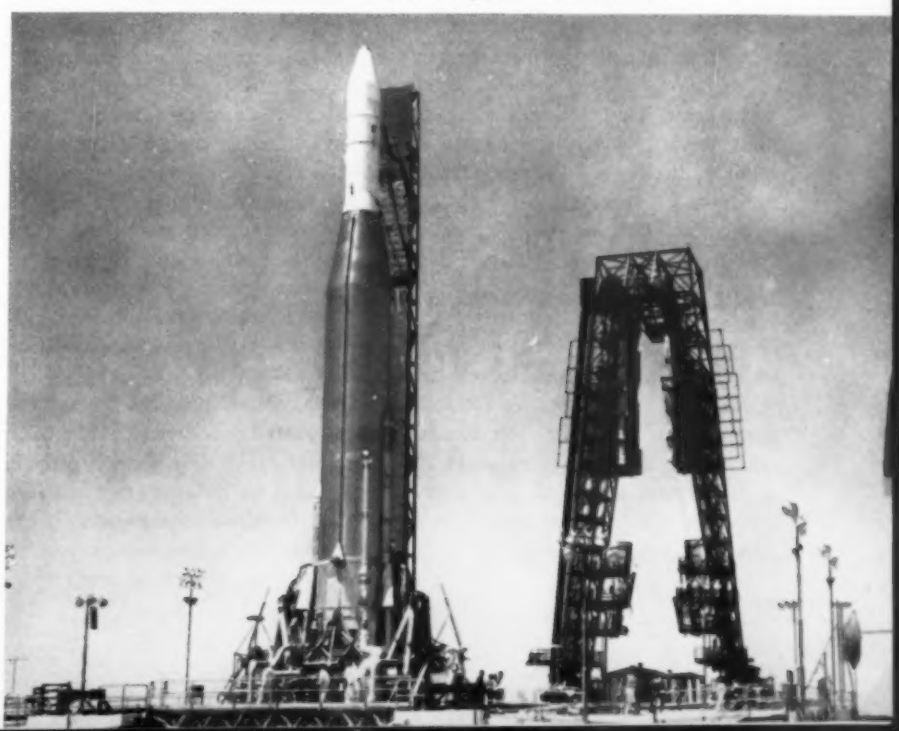
Looking still farther into the future and deeper into space, the Air Force has let industry contracts for broad studies of interplanetary vehicles and their strategic weapon systems capability. Military space stations might be required, for example, to guard scientific space expeditions and bases established on the moon or the planets. In this field the ideas become truly "far out," including such concepts as the development of rays capable of destroying men and their vehicles.

Using a Douglas Thor IRBM as a booster and carrying an Agena vehicle as second stage, Discoverer XIV was successfully launched late last summer.

Air Force leaders say the United States must look into the area of space weapons development because the Russians will use space for military purposes when it is to their advantage.

Says General Schriever: "It is apparent that as missile and space technology moves forward both the U.S.S.R. and this country will have an ever-increasing military potential. To take maximum advantage of our development efforts, we must recognize that there are military missions which can be performed more efficiently and more economically through the use of space vehicles, and there are other military missions which can only be satisfied by the use of space vehicles."

The huge Air Force Atlas space booster is shown here mated with an Agena satellite vehicle for global reconnaissance.



The New Warfare

It is a struggle of proving grounds and laboratories rather than of battlefields, and the U. S. must spend for weapons research, knowing that many military developments eventually will find peacetime uses

Garrett Underhill

THE Presidential election campaigns of this year have made it startlingly clear that the U. S. military-industry team is being called on to meet a new Communist threat to national survival. This threat is as incalculable in the vastness of its apparent time and scope dimensions as it is novel as a problem for defense industry and the professional military.

Moreover, this new threat in no way replaces any existing Communist menace to American security. It must be added to the threat of military aggression America has learned to recognize and deter since World War II.

In their speeches accepting their nominations, both Presidential candidates were in substantial agreement as to the nature of this new threat and its relation to the military menace. They both stressed the need to meet the new challenges with new thought, determined spirit, and broad-scale action. In effect the candidates issued a bipartisan political directive to all associated with science and technology in government and civil life, and particularly to the military-industry team.

Both candidates recognized, in effect, that there is under way (to use Gov. Nelson Rockefeller's words) "an exciting scientific and technological revolution which will dramatically change the whole character of life in America and the world in our time." This revolution, they warned, must be American, not Communist.

Mr. Underhill is a recognized authority on military weapons, having served with the Army Intelligence Corps in both World War II and the Korean emergency. He now resides in Washington, D. C.

Is the military-industry team, which to date has done so well in meeting the Soviet military menace, ready to pitch in to meet the new threat? Is it of a mind and form to add this great and practically uncharted task to the huge one of military defense it has borne for so long?

And what will the new task mean in terms of the tax burden, both corporate and individual? With the Federal Government hard put to find funds for present purely military defense programs, can a new kind of defense effort be superimposed without serious economic consequences?

Indications are that, of all available groups in the Nation, the military-industry team is far more ready to take on the new challenge than some may think. The work to be done, far from burdening business and the individual citizen, promises to prove a boon to all.

Indeed, developments during the 1950's altered the character of the U. S. Defense Establishment so as to make it well suited for the times to come. It is already, for all practical purposes if not by policy and intent, dual-purpose in basic nature. As such, it is well prepared readily and effectively to adapt itself to victory-producing teamwork with industry for the new kind of "war without war." This it easily can do by development of the proven ways by which this teamwork has sustained American military security—and, in the eyes of the world, performed seeming miracles—for the last half century in wars cold and hot.

AS a military institution, the Defense Establishment fulfills its primary purpose by providing security against aggression. But as the free world's largest research and development sponsor and establishment, and as a gigantic test and evaluation proving ground, it has, in practice, also served to develop human and material science and engineering, skills and know-how. In fact, in recent years it has served industry and mankind in general as a principal source of the knowledge and the means to make progress for the general good of mankind.

Just as defense has changed in character, so has the significance of defense spending. Under present circumstances, defense no longer can be regarded as a drain in money and manpower upon the vigor of the national economy. Instead, it gives the citizen the best bargain possible for his tax dollar. It insures his family, self, and worldly goods from aggression. Simultaneously it constitutes an investment in future riches and welfare incalculable in value,

and geometrical (if the past is any indication) as to its potential for progress.

What the military-industry team has achieved for civilian life, purely as unintentional by-products of its military research and development, suggests what is achievable were there a conscious fostering of this dual-purpose nature of the Defense Establishment.

Take, for example, long-range ballistic missiles. While they were being developed, the pacifist viewed them with horror as the acme of utterly useless, fabulously costly tools of total war. If only the millions so "wasted" could be spent on socially useful public works, like highways, or on helping farmers with their problems!

Today it is known that ballistic missiles are more likely to go down in history as aids to travel and agriculture than as war weapons. Transit navigational satellites—the first launched by a Thor missile in 1960—should be in operation in 1962 on a scale sufficient to afford aircraft and ships far more precise "fixes" than ever before possible. And fixing upon such satellites will be far freer from weather interference than conventional media. In effect, then, ballistic missiles are giving us better highways for air and sea craft, than the world ever had before.

A THOR missile also lofted the first weather satellite. As the program of which it is a part develops, the scientists' weather-observation net will be extended from its present meager coverage of about a fifth of the world's surface, to a complete view. It then will be possible to understand the forces that create weather. In so doing not only agriculture but countless human activities will benefit immeasurably.

The Army Chemical Corps produced a compound known as DFP for its "nerve gas" program. It has turned out to be excellent for the treatment of certain eye troubles. A system worked out by the Office of Naval Research for electronically operated missile systems has proved of inestimable value in speeding the lowering and raising of body temperatures during heart and lung operations. Intravenous injection of mustard gas has been found to aid the treatment of cancer.

The frozen TV dinner has become a lifesaver to the housewife and bachelor alike. However, originally it wasn't conceived for them but by the U. S. Air Force to provide balanced, interesting meals for bomber crews whose missions could last two full days.

The Navy perfected echo sounding for submarine location. Professional and amateur fishermen alike use it to locate fish and for navigation. Radar was devised for air defense. Today it has a host of uses, from enabling harbor tugs to operate in otherwise impossible weather to detecting turbulence ahead of transport aircraft so passengers may ride smoothly and safely. Without it traffic control at commercial airports would have been swamped long ago, and all-weather commercial flying would have been out of the question.

Radar has in large part facilitated the transport revolution of the 1950's, wherein the position of railways and airlines as the No. One passenger carrier has been reversed.

Military pioneering has paid off for civil life not only in specific products but in many other ways. It has ushered in the use of many new materials. Without the expansion of plant and know-how for aluminum production for the gigantic World War II aircraft program, the virtual universality of this material in U. S. economic life could not have been achieved.

Processing has been pioneered. Faced with the need to manufacture millions of rifles at short notice, and to do so with little skilled labor while attaining the highest degree of ruggedness and reliability of product, Army Ordnance's Springfield Armory developed broaching tools during the 1930's. (The Chrysler Corporation attempted parallel pioneering for auto making, but the depression of the 1930's forced it to drop the program.)

"The military function is not a merely negative one of averting war and perhaps of having virtually to destroy civilization should war come . . . It must serve as pioneer and guide to the creation of an ever-improving civilization."

Printed circuits, now so effective and cheap a means of assisting in the home-appliance industry, were pioneered by the Air Force to reduce manufacturing and maintenance costs and increase circuitry reliability. The method also reduces the chance for human error in manufacture and repair.

As for administration and management, electronic computers, now with a host of business and industry uses, were first called for in 1942 because Army Ordnance's Ballistic Research Laboratories needed a faster way of calculating trajectories and firing tables.

The concept of statistical control was originally worked up and introduced by International Business Machines' personnel on World War II active duty with the Army Air Forces. The need for a drastically new way of handling spare-parts inventories was impressed upon them by the tremendous scale and global nature of the wartime air effort.

Military historians know that there is nothing basically new in the accruing of great benefits to civilian life from developments undertaken for military purposes. Of the cheap process which Sir Henry Bessemer devised to aid steel making, the Encyclopædia Brittannica says: "Bessemer's attention was drawn to the problem of steel manufacture in the course of an attempt to improve the construction of guns."

NAPOLEON'S concern for supply brought into being the art of food preservation. (Jars were used then; the latest military contribution is moisture-proof food packaging.)

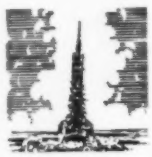
The Allied blockade of Germany in World War I caused the origination of the Haber-Oswald process of fixing nitrogen from the air. The U. S. Army's pioneering of medical advances of direct benefit to mankind (like that of the discovery and prevention of yellow fever) has been hailed for decades.

However, the changing character of modern military establishments and civilization, as well as of science and technology, has made it the rule, rather than the exception, for the military to pioneer (albeit for war pur-

poses), technological progress useful in general life.

In the old days, armies had animal and "shank's mare" locomotion. There wasn't much science and technology could do to better man and beast. (The Army was unable to initiate a program of motorization and armoring until 1939.) Until the introduction of steel and steam, navies depended for mobility on men, wood, wind, and canvas. Not much could be done about these factors, either.

But as civilization became more technical, so did defense forces. It follows that military authorities at all levels will strive to assure that military means of communication, administration, logistics, transportation, and living—all the host of considerations incorporated in institutions dedicated to ensuring national survival—will be the result of attempts to profit from all that science and technology can achieve.



In the past, what the U. S. military sought most from technology was production. Before the Cold War began in 1947, the peacetime armed forces of the U. S. were miniscule. They relied upon being greatly expanded in men and matériel in the very face of an emergency, as was done in both World Wars. There wasn't time to create and use much in the way of advanced technology once mobilization began.

NOW, however, there is a very different state of affairs. The National Science Foundation chart on page 57 serves to illustrate what has happened, and is happening, because in the main Federal research and development funding is directly or indirectly for defense purposes. The chart shows:

1. That research and development funding even in fiscal year 1940 (when rearmament was getting under way) was, in terms of today's programs, virtually zero (less than two per cent of 1959).

2. That the peak R&D spending rate during the all-out national World War II effort was less than that for the year following the end of the Korean war (fiscal 1954).

3. That in the past half-decade America has adopted a policy of vast and constantly increasing research and development effort in peacetime, with the result that R&D spending of 1959 was 107 per cent that of 1953.

The U. S. military-industry team, then, has been driving so hard for progress in defense technology that it has caused a virtual scientific-technological explosion. As a result, the relative importance of progress and production to the military has already undergone a marked change. It is clear that as the primary path to progress, for the defense forces at least, research and development is coming to be not a mere means to a production end, but very much of an end in itself.

While the nature of the armed forces has changed, the nature of science and technology itself also has changed. The day is past when great results could be expected from impoverished but dedicated inventors, working in kitchens or backyard sheds. Aircraft companies no longer can turn out great airplanes in converted garages and barns, on financial shoestrings.

Progress these days involves immense and complex problems of discovering and exploiting intricate new relationships of man to nature. The plains of nature, where progress is easy, now have been well-scouted. Science and technology now must pioneer increasingly difficult terrain.

The example of the aircraft industry well illustrates both how the R&D job is harder and how, therefore, industry has become more dependent on military-funded pioneering not only for militarily useful developments but also for commercial ones.

In 1934 the Boeing Airplane Company, believing its concept of the future bomber better than the official ones, designed and built the first B-17 Flying Fortress as a private venture. Today the B-70 supersonic bomber development requires a complex of major aircraft industries, each of which renders the Boeing firm of the 1930's Lilliputian by comparison. And this is not because the aircraft industry has abandoned private enterprise effort for Federal nourishment of research and development. The industry reinvests in itself over sixty per cent of its income dollar. Since World War II it has averaged at least a billion dollars a year in private spending on R&D.

In 1933 Douglas risked $275,000 of its own money (TWA airline put up $125,000) to create a type of airplane—the DC-3—which for over 15 years was the work horse of both commercial and military airways (Iron Curtain countries included). It marked an era because it put airlines in the black for the first time.

To create the DC-8 jet of 1960, Douglas ventured $250 million of its own and others' money. As things stand, neither Douglas nor its airline customers know whether they will make or lose money with a plane far more important to transport than was the revolutionary DC-3.

YET the DC-8, like the similar Boeing 707 and Convair 880, was undertaken only after the military had the most extensive experience with big jets. Although the similarity of design concept of these jets to the Boeing B-47 bomber is obvious, the B-47 first flew in 1947 while the 707 wasn't begun until 1952 and didn't enter service until 1958. The DC-8 began operations in 1959; the 880 in 1960.

The lag between the military big jet bomber and the commercial jet transports is vital to note because it points up the increasing value for commercial technology of the actual manufacture and operation of military counterparts. For before the U. S. aircraft industry and its worldwide airline customers felt ready to risk their money on commercial jets, they had to gain the advantage of the knowledge and experience furnished by production and operations for the military.

This is in line with what Maj. Gen. Leslie J. Simon used to stress when he was Chief of Army Ordnance research and development back in 1951-1955: that R&D of a level of the technological art can be considered finalized only when there has been considerable experience in the industrial manufacture and field use of an application.

In some important respects, the aircraft industry is not a good example with which to illustrate past changes and present conditions.

For one thing, the aircraft industry has continued to take remarkable risks with its own money. Therefore it fails to disclose an alteration which greatly has affected the U. S. economy in the last generation and which bears on the utility of exploiting military-industry teamwork to meet the new-type Communist threat.

THE change that has come about in the economy often is called the "managerial revolution." In the old days of industrial "robber barons" of great personal fortune and absolute control of industrial empires, important new concepts could and were backed on a free-private-enterprise basis. In present days, corporate direction must bear in mind the need to pay regular dividends to stockholders who represent union and company pension funds, insurance firms, and the income of widows and orphans. Costly, large-scale, high-risk, long-term, and uncertain-outcome projects, be they commercial or military, no longer can be considered for private funding as they once were. High corporate taxes further inhibit private R&D ventures. Despite R&D cost write-offs, conservative corporate policies must prevail.

The aircraft industry also is atypical of U. S. industry in general in that it is perhaps the most R&D-conscious and aggressive industry in the free world. For example, of the one-fifth increase in research and development spending of 1957 over 1956, the aircraft and related industries accounted for about 70 per cent. Of the $1.2 billion increase, the aircraft industry accounted for $436 million, electrical equipment $228, and machinery $126. All other industries had increases down in the $6 to $46 million bracket.

The performance of the aircraft industry, and of certain related industries, therefore tends to obscure a most important change which has taken place on the scientific-technological scene in the past generation. The change is the way private industry has been surpassed since 1940 by the military establishment as regards exploitation and creation of technology.

Before World War II, military men often complained that defense lagged 50 years behind commerce in making the most of science and engineering. World War II effected a radical change, and now over fifty per cent of the total annual R&D outlay is funded by the Federal Government, and that largely for defense. (This fact gains significance when total annual defense expenditures of around $42 billion are compared with a gross national product of around $500 billion.)

Obviously impressed with what has been achieved by R&D for defense purposes, in the 1950's industry began awakening to the need to exploit the R&D art. In the period 1953-1956 alone industry R&D spending went up forty-four per cent. The key to successful competition and better profits is being linked with making progress as never before.

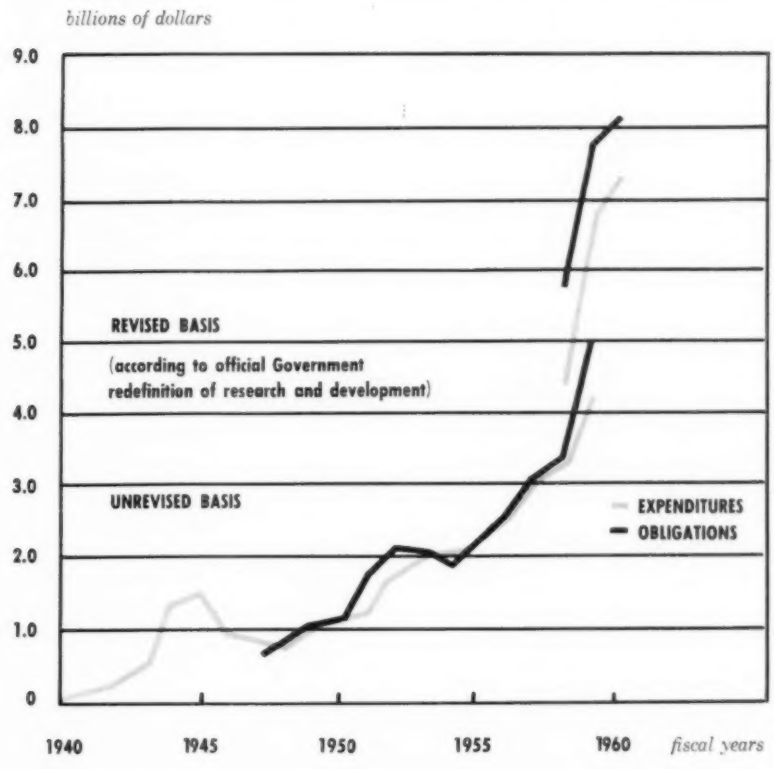
Indeed, industry appears to be following the example of the military. It may be shifting from emphasis on production to stress on progress, with improved quality for life and reliability included in the definition of progress.

The aircraft industry again furnishes examples of what can happen. In the post-World War II days when the 4-engined piston-propeller transport was long-range king of the world airways, U. S. industry sold over 1,500 such planes for commercial purposes. By introducing the current jet generation, the industry has rendered obsolete the piston-propeller fleet, but only expects to sell around 500 big jets.

WHEN the supersonic transport is introduced (which could be by 1970), as few as 120 such craft may take care of the whole world's long-range requirements and absorb great passenger traffic increases as well. Moreover the spares business has gone down, and will descend further. The most powerful piston engines can be operated about 1,200 hours between overhauls; one British turbine engine of much greater power is already cleared for 3,000 hours for commercial operations before overhaul.

Progress for private enterprise, then, can mean that a few new products will do the job of many older ones. They can last longer and take care of expanded markets. In effect they can be

Trends in Federal obligations and expenditures for research and development.



the commercial equivalents of the military "bigger bang for a buck." But, as in the case of the military, progress also means that there will be many new kinds of products to sell.

When account is taken of past and present changes affecting defense, industry, and the scientific-technological situation, it would appear that something on the order of the present military-industry team is need to arm America for the new "war" which her political leaders have in effect declared.

The existence and experience of the Defense Establishment, and its having developed a dual-purpose utility of great effectiveness without intent or planning, suggest that the efficient and economical way to "fight" the new "war" may be to exploit the *de facto* situation.

Consider, for example, the position of the Army. It has three principal fields of interest which indisputably are its sole military province: land locomotion, light aviation, and guns. Each has the broadest of implications in huge segments of the civilian economy. Land locomotion concerns the automotive field, and cars and trucks concern the mobility of every American and his supply. Military land locomotion stresses off-road travel.

ON the civilian side, Army progress in this sphere affects agricultural and construction machinery. It undoubtedly will also come to affect areas where road and bridge construction is costly, provided that the Army is helped to achieve ever-greater efficiency and economy in off-road vehicles.

Light aircraft for business and agricultural purposes already number over 65,000. The industry is expanding by leaps and bounds on the technological level already established, overshadowing its military counterpart. (The Army takes only about a fifth of the engines produced monthly for this class of aircraft.) Incalculable further civilian growth awaits perfection of reliable, economical, vertical-flight light aircraft. The advent of swift jet transports and the build-up of surface traffic problems make such craft already much overdue as intra- and interurban short-haul passenger ferries.

The Navy, let it be said, has for decades been fostering the dual-purpose concept as fundamental for sound sea power. Such a double function was inherent in the very definition of sea power made by its great protagonist, Capt. Alfred Thayer Mahan.

MENTION of Mahan is definitely in order, because what America's situation today demands is the thinking out of the new power situation in the Mahan manner. Indeed, the natural yet unplanned evolution of a dual-purpose U. S. defense establishment is like the unplanned evolution of British sea power prior to Mahan. And like British sea power in the eighteenth century, the dual-purpose "R&D power" of the American twentieth century military-industry team awaits recognition and rationalization.

Properly "Mahaned," this power can be given the form and firm direction that can assure the quickest victory at least cost of money and effort.

The implications are obvious that industry will have to shoulder a far greater share of the thinking and planning burden for this new "war." In the past it has left much to the military on the grounds that the end problems were military. However, in the new war, the end problems are economic—commercial, in fact. Indeed, as the new war is won, the danger of military conflict will diminish. The more progress that is made, and the stronger in consequence the free world economy, the less favorable in technological and general strength will be the Communist position for a military war.

Also obvious are the implications that there will have to be some authority higher than present military chiefs to decide on issues involving adaptability and capability for both military and commercial war. The Soviets long have had organization for such decision making. The British, in aviation at least, have had it since World War II.

"The Defense Establishment... as the free world's largest research and development sponsor and establishment and as a gigantic test and evaluation proving ground has . . . served to develop human and material science and engineering."

As matters now stand, defense policies often call for R&D projects to be designed to meet purely military requirements. For example, Army aviation is pursuing the "military requirements above all" policy for helicopters. Yet since they started an all-out drive for helicopter transport in 1949, the Soviets have made sure that their rotary-wing craft are dual-purpose. The same goes for heavy air transport.

The Soviets have a turbine-powered plane which fulfills a dual military and commercial cargo role (they have sold eight to India; are seeking other customers outside the Iron Curtain). The American counterpart doesn't meet commercial requirements, so that some U. S. cargo airlines are buying Canadian planes with British engines. One U. S. line is flying cargo on a U. S. Air Force contract using an all-British cargo turboprop.

SURELY the pursuing of such policies, when the Soviets are following policies adapted to the new "war," is not the way to answer the call of America's new political leaders for winning out in the contest to make progress and advance American economic growth. Commercial "weapons" are needed to "fight" the Soviets in the commercial "war" right now.

However such problems should easily be solved. The military today has a knowledge of commerce and industry unparalleled in any military establishment in history. Industry has likewise acquired a thorough knowledge of the military. It has present in its ranks millions who have served in the armed forces since 1939. Above all it has numbers of retired officers of the highest professional and business competence.

The Soviets have achieved an average R&D lead time of four years to America's eight, so there is much time to be made up. Ground has been lost which must be regained.

In any event, the battle is already joined. The forces, without their realizing it, have organized themselves and are fighting and fighting well. It only remains for the U. S. to recognize the situation and resolve to be victorious in this new warfare.

Intelligence Is the Key

It is of the utmost importance to our peace, prosperity, and very existence that we know the military capabilities of any potential adversary so that we can be sufficiently prepared to resist him

Harold Tombach

WE have entered an era where a surprise attack with nuclear weapons can literally wipe out an unprepared nation in a matter of minutes. To be prepared, we need reliable long-term intelligence forecasts of potential threats and timely attack warning. An integration of latest scientific achievements, of effective organization, and of monetary funds can provide us with intelligence information without which not only peace and prosperity but mere national survival is questionable.

The realization of peace and prosperity in the decade that lies before us will depend on many factors. One of them is the international environment in which we have to exist and which is not entirely of our own making. Understanding of this international environment in general, and knowledge and prediction of capabilities and of likely actions of unfriendly countries in particular, are necessary for the attainment of our national goal of peace and prosperity.

It is not difficult to see that reliable intelligence information is required for the preservation of peace. As long as there are countries with imperialistic ambitions and capabilities, we can preserve our peace only by preventing these countries from attacking us or any one of our friends whom we would assist militarily in the event of an aggression.

In other words, the only way, even though not a sure one, for us to stay out of war is through deterrence. It is important to note here that the concept of deterrence implies that the would-be aggressor believes that we have the capability and the intent to punish him seriously should he engage in activities that exceed our threshold of tolerance.

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We will not discuss here the important matter of how we can convince a potential aggressor of our willingness to use our military capabilities under various possible circumstances. It is, however, clear that our *willingness* to deter will matter little if we do not have the *capability* to do so. It is unlikely that we would succeed in bluffing, since it is, unfortunately, comparatively easy for a would-be aggressor to ascertain our real deterrent capability.

The latter will depend on the offensive weapons we will have operational at the outbreak of hostilities, on our ability to protect these weapons from destruction by the enemy should he attack us first, on our knowledge of the location of enemy targets, and on the ability of the enemy to defend himself against our offensive weapons.

It is thus clear that the effectiveness of our deterrent force depends on our knowledge of the offensive and defensive potential of the would-be enemy. This knowledge is needed far ahead of the actual outbreak of hostilities because of the long lead time (five to ten years) associated with the development of new weapons. Otherwise, we might find at the outbreak of hostilities that the enemy has offensive weapons that can destroy ours before we can use them or that he has defensive weapons that can prevent our offensive weapons from inflicting any appreciable harm. Long-term intelligence is therefore a must for effective deterrence.

IT must be realized, however, that deterrence is not a one hundred per cent sure device for preventing war—there could be a "fool" who would unleash a war either because he did not believe in our deterrence or because he had confidence in his ability to cope with our retaliatory strike. Or perhaps it could be that he hoped to win the war and did not care about the magnitude of his own losses.

In this event, the existence and proper functioning of an intelligence system that would provide maximum short-term warning both of the imminence of an attack and of the attack itself may become the key to survival. If the success of enemy's offensive is predicated on his achievement of surprise, and we let him know before he attacks us

Phase	*Events*	*Likelihood of Attack*
Build-up of offensive capability	Development and production of offensive weapons	Decision to attack may never be made
Offense prelaunch activities	Decision to attack Preparations for attack	Decision to attack may be reversed
	Order to attack	Order to attack may be revoked
Offense in progress	Launching of weapon carriers	
	Activation of weapons Weapon impact on targets	Attack is certain

Sequence of events in the development of an attack.

that we are prepared, peace still may be preserved and our intelligence capability will then have contributed to deterrence.

Effective intelligence also can contribute to national prosperity. Short of actual war, an astute enemy—and this is the kind we will be confronting—can force us into much unnecessary defense spending simply by making us guess as to what he has up his sleeve.

FOR example, the effectiveness of our retaliatory force depends on the ineffectiveness of his defense. Should he develop an effective defense, the much-advertised "balance of terror" would disappear. If we still want to survive, we will have to make a big effort to develop and procure effective defenses ourselves.

Investment in intelligence that will improve our knowledge of future threats thus can contribute to national prosperity by reducing the amount of money spent on "cures" for which there may be no "diseases."

We have established the need for good long-term and short-term intelligence. The better we can make both kinds of intelligence, the better are our prospects for peace and prosperity. Let us now examine how our intelligence capability can be improved.

It is somewhat of an understatement to say that intelligence is many-faceted when one considers the multitude of possible sources of intelligence data and the variety of applications of analyzed and synthetized intelligence information. From the point of view of usefulness of intelligence for the preservation of peace and prosperity, however, there is one area where the contribution of intelligence is critical—the defense of the continental United States. An examination of the role of intelligence in this area is instructive.

The earliest indication of possible danger is the development by a potential enemy of weapons that may be used to attack our country. While the development of such weapons and even their subsequent production are not a positive indication that they actually will ever be used against us, it is of utmost importance that such developments be detected in their earliest stages and that their threat be assessed.

It takes years to develop new weapons and measures to counteract a novel form of threat—as witnessed by the fact that we have not yet developed an active defense against already existing ballistic missiles, even though we have had many years of forewarning.

THE detection of this development work and of the subsequent phases, if any, of weapon production, deployment, preattack activities, and of the attack itself is the job of our intelligence and warning organization. The latter must not only detect, evaluate, and correlate facts but also must be able, on the basis of these facts, to predict the likelihood of future events.

An intelligence and warning organization has to fulfill four functions: (1) collection of information by primary intelligence sources; (2) transmission of this information to a central information processing unit; (3) evaluation, correlation, and integration of received information by this central unit; and (4) presentation or display of evaluated and integrated information, or of future estimates derived from it, to proper authorities for decision making.

An improvement in any one of these four functional areas would better the over-all performance of the intelligence organization. Keeping in mind that it

How long-term and short-term intelligence can contribute to the preservation of peace and prosperity.

The contribution of INTELLIGENCE ↓ to →	PEACE	PROSPERITY
Long-term threat estimates (by Central Intelligence Agency, Aerospace Technical Intelligence Center, etc.)	point out weapon systems required for effective deterrence	make it possible to avoid spending money on useless weapon systems
Preattack warning (by reconnaissance aircraft, earth satellites, agents, etc.)	may avert enemy attack if its success is predicated on surprise and we let the enemy know that we are prepared	may substantially reduce enemy attack damage to population and economy if proper active and passive defense capability exist and is being employed
Tactical intelligence (by Distant Early Warning lines, Ballistic Missile Early Warning System, etc.)	enhances deterrence if enemy believes that it will contribute to our retaliatory capability	

is the time of the first detection of a potentially dangerous development that determines the maximum amount of warning time that the most perfect intelligence system can provide, we will now examine some of the ways of improving the over-all performance of threat intelligence.

An intelligence report or estimate is the more valuable the earlier it is produced and the higher its reliability. The decision maker to whom the intelligence information is presented must have confidence in its reliability so as to be prompted to make the necessary decision, and he must get it early enough for his decision to be effective.

IN order to maximize timeliness, it is necessary that any event of intelligence value be detected as soon as it occurs and that the processing of intelligence information be as rapid as possible. The probability of early detection of significant events can be increased by multiplication and diversification of intelligence input sources. More money can buy more agents and also more physical sensors of more kinds. Thanks to scientific discoveries and technological achievements, some already proved means and many new not yet fully tested developments have tremendously increased the variety of tools in the intelligence kit.

Among them, a prominent role is played by earth satellites equipped with optical, electronic, and heat sensors. The first type relies on visual observation and photography of enemy territory, the second on well-established radar techniques, and the third on sensing of temperature differences of objects on the ground (for instance, concrete runway versus grass cover) or above ground (for instance, the hot rocket exhaust of a missile in flight).

It is possible that the contributions to intelligence provided by these various types of earth satellites will eventually make it virtually impossible to conceal important military activities for any length of time.

In addition to these "spy-in-the-sky" satellites, other sources such as beyond-the-horizon radars, reconnaissance aircraft and ships, and chemical air analyses are only a few examples of the wide variety of means for obtaining intelligence information on nuclear tests, missile launchings, the location of strategic bases, etc.

102L — High-altitude SAC reconnaissance system RB-58
117L — Advanced reconnaissance satellite system
117M — Operational Samos
239A — Operational Midas (Missile Defense Alarm System)
323A — Tactical Strike Reconnaissance System
413L — DEW (Distant Early Warning) System
416L — Continental AC & W Support System
438L — Intelligence data handling system
464L — Dyna-Soar
466L — ELMINT (Electromagnetic Intelligence System)
474L — BMEWS (Ballistic Missiles Early Warning System)
496L — Spacetrack (Space Surveillance System)

Partial list of Air Force intelligence systems.

The nature of intelligence is such that, in most cases, evaluation and correlation of a huge amount of data are required before reliable conclusions can be drawn. This data processing is time consuming.

Fortunately, more extensive application of technological achievements in the areas of automatic electronic transmission of information, of data processing by electronic computers, and of automatic information displays is capable in many cases of reducing considerably the processing time of intelligence information.

The use of electronic computers permits speeding up many of the time-consuming operations of storage, indexing, and retrieval of information, comparison of existing information with new data, correlation of data, and computation of scientific inferences. (It should be noted here, however, that it is not conceivable that machines will ever be able to substitute completely for the analytical ability of human experts.)

THERE are thus means to improve on the timeliness requirement of intelligence. Of these means, increasing the number of input sources and diversifying their kinds also can improve the reliability of digested intelligence information.

Because of the inherent unreliability of any one single intelligence source due to possibilities of error of the sensing equipment or person and to the likelihood of feints, diversions, and deliberately planted misinformation by the opponent, the probability of an estimate being reliable generally improves as the number of inputs to the estimate increases and as inputs from different kinds of sources corroborate each other.

Radars are subject to electronic countermeasures, infrared heat sensors could be misled by flares, visual observation or optical photography can be fooled by camouflage and is not usable during darkness, agents may be mistaken or lie, economic indices may be caused to fluctuate by reasons other than those assumed, etc.

THE improvement of reliability through correlation of a multitude of facts points out the desirability of maximum centralization of intelligence activities. This again points out the necessity of making more and better use of electronic data-processing machinery so that all pertinent factual intelligence information may be used to produce the desired integrated intelligence input in an acceptable length of processing time.

Of course, all this costs money, but when one considers all the gains that more timely and more reliable intelligence warning can provide, then it becomes clear that investment in improved intelligence is indeed worth while. It can be not only our key to peace and prosperity but even may be our key to survival.

Civil War Ordnance—VII

Arms for the Men

Despite a reduced stockpile of weapons, shortages of materials, and official obstructionism in some cases, the North and South equipped themselves with enough small arms and artillery to fight a major war

F. W. Foster Gleason

NOT a little of the force of Civil War weaponry stems from the 1847 siege of Vera Cruz. The young officer who there commanded the U. S. Ordance detachment became, fourteen years thereafter, Chief of Ordnance of the Confederacy. Because of the grave deficiencies of Army Ordnance at Vera Cruz, he determined that wherever he might be there would always be "enough ordnance, on the spot, and on time!"

He developed such tactical prescience that, more than once, Confederate commanders were first appraised of impending danger by the receipt of great quantities of unordered munitions to fight campaigns that Gorgas' ordnance-schooled mind had foreseen.

Weaponry—in the sense of matching one's tactics to the weapons of one's self and the enemy—is no new thing. Alexander matched his tactic of "the right offered and the left refused" to his phalanx, heavy cavalry, and light-armed troops. The Mongol horseman's bow coupled with the feigned retreat met no check for fifty years till Baibars of Egypt copied bow and tactic and overwhelmed Kit Boga at Ain Jalut.

BY combining the longbow with their static "hedgehog" defense, 14,000 English broke 50,000 French at Agincourt and dominated France for a generation. Ever since David matched his sling to his unarmored mobility, the formula has been potent. But it is never automatic—it must be planned—and to plan, the weapons must be known and understood.

Mr. Gleason is a recognized authority on ordnance of the American Civil War. During World War II, he was a member of the historical section of the Office, Chief of Army Ordnance, and has since increased his reputation as an editor and writer of military history. He resides in Washington, D. C.

When field command lacks this understanding, defeat or needless losses occur. Yet the prime source of the soldier's knowledge is military history, and few historians seem aware of any need to know and to record this vital facet. Nearly all military history is compiled from the viewpoint of the adjutant general!

No need to read whole volumes to prove this—just turn to their indices and try to find "arms, guns, ordnance, rifles, or weapons." Where, then, is the writer to find the knowledge that he should pass on to the soldier? Recent volumes show some improvement but not enough—it is still a grave challenge to every historian, every student, every ordnanceman.

Much of the ever-growing interest in the Civil War stems from the fact that it was the first industrial war, the first railway war, the first telegraph war. Not all realize that it also was the first rifle war—the first war in which the rifle became the nearly universal weapon of the infantry with accompanying changes in battlefield tactics.

Rifling had appeared in the early 1500's. But with no practicable system of breech closure being known for centuries, the problem always remained of getting the ball, oversized to fill the spiral grooves, down a long barrel. The rifleman carried a mallet and hammered it down—just too slow for battle!

The patched-ball of the "Kentucky" rifle was enough improvement to father the myth that "the rifle won the War of the Revolution" and, of course, the battle of New Orleans. But in fact it was still unsuitable for combat.

IN the Mexican War all regulars carried the flintlock smoothbore. A few volunteers had the M1842 caplock—the first regulation U. S. arm with rifled bore—but it was as slow to load as any other patched-ball rifle.

In 1846, Captain Henri Minié of the French artillery solved the 300-year-old problem. His undersized cylindroconoidal bullet dropped freely down the bore and, on firing, its hollow base expanded into the grooves. By 1852, Harpers Ferry Arsenal had improved the slug and, three years later, developed the first American rifle designed for its use. Some Miniés had been used in the Crimea but affected tactics not a all; that would come with the mobile fighting of the Civil War as the inherent

power of the new arm showed up.

Its rate of fire equaled that of the smoothbore; fouling, bane of all black-powder arms, was less, for the tight slug scoured the bore; and the heavy, elongated bullet held its accuracy far beyond the range of any ball.

The smoothbore's effective range (at which casualties became demoralizing) was 100 yards. The old rifle was accurate at 200, but its slow fire reduced its effect. The Minié was effective to 400 yards, and veterans increased even this range. Defense had received a great boost: cavalry's threat was gone, pursuit was more difficult, the improved field gun was held beyond its optimum range, and entrenchment became a must.

Not all this appeared at once, for not all infantry were to be rifle-armed for a year or more. Even when rifles predominated, most field officers required a bloody lesson or two, and some never learned. Even R. E. Lee, later to introduce the general use of fieldworks to mobile warfare, was slow to act.

THE U. S. recognized some 120 firearms for infantry and cavalry, the Confederacy almost as many. The great majority were just "anything that would shoot."

The exact totals of men in the Civil War are far from certain; the totals of arms, much less certain in many cases. At the start, the South possessed about 30,000 military rifles; the North some 55,000. Three types made up the bulk of these: (1) the "Mississippi," rebored from caliber .54 to the standard Minié caliber .58; (2) the Harpers Ferry; and (3) the 1855 Springfield (first of four very similar models). All three were good rifles and served through the war, but there were just not enough to arm the first volunteers of either side. Southern rifles came through seizure or had been kept by Mexican War veterans; Northern were from armories and the 16,000-man Army.

Progress in arming was slow—it always is! In late 1861, McClellan complained bitterly of his "miserable arms." Captain Thomason tells us that in the spring of 1862 "Confederate regiments were going into battle armed with shotguns, while excellent rifles reposed in State armories." As late as July 1863, Grant ordered his troops to exchange their arms for the best of the 60,000 taken at Vicksburg.

Springfield Armory and contractors made 1,476,219 rifles by 1865. While waiting for the tool-up, the Government bought 428,292 English Enfields and the Northern States almost as many. These two armed the bulk of the Union infantry.

The best weapon of the Confederacy, 1862-1865, was this same Enfield. Southern records—never too full, and scattered at the end—must be eked out by reconstruction. Several large lots ran the blockade, augmented by a constant trickle; a fair number were made in the South; capture brought many more.

It appears that the Confederacy "begged, borrowed, and stole" well over a half million of these excellent arms. As bullet diameter of the Springfield and Enfield differed little (.577 and .569, respectively), the cartridges were reasonably satisfactory when interchanged by capture or by error.

By 1863, the Army of the Potomac had replaced all smoothbores; not so the Army of Northern Virginia. Final and tragic proof that Jackson was shot by his own troops came with the removal of a caliber .69 ball from his hand.

Poverty, blockade, and lack of machines and materials doomed the South to ordnance inferiority. Wealth and industrial predominance of the North should have made the gap even wider.

Two men intervened: James W. Ripley was U. S. Chief of Ordnance from August 1861 to September 1863. Not even Lincoln could fire that glacial mind—and it took him two years to fire Ripley! Josiah Gorgas of Pennsylvania was Chief of the Bureau of Ordnance, C.S.A., during the entire conflict. A genius of administration and of weaponry, his specialty was the impossible.

The weapons gap remained to the end, but the slow match at Washington and the hotshot at Richmond cooperated nobly to narrow it for two years.

The question has often been asked, "Why did not the North turn at once to the breechloader and the repeater?" The query ignores hard facts. The blind parsimony of Congress in the pacifist 1930's was nearly matched by that of the pre-Civil War Congress. And the denigration of ordnance by the Gerald Nye-Alger Hiss Munitions Committee in the mid-1930's was nearly paralleled by the dictum of the early Congress that no patentable arms could be purchased without special legislation! And "promising" weapons are no substitute for those that have passed long and grueling field tests.

But the Army had the 1859 Sharps in small numbers. It was a falling-block rifle that fired ten shots a minute to three for the Minié. Though its breech leaked and fouled, it became the choice of Berdan's sharpshooters. So the Government splurged—it purchased nearly 10,000! The South bought 1,000 and manufactured some thousands of the rifle.

THE Spencer 7-shot repeater was reliable though not particularly long ranged. The North bought 9,141 Spencer rifles and 94,000 carbines. The South could not furnish the metallic cartridges even for captured Spencers.

Undoubtedly the finest small arm of the war was the Henry 15-shot rifle. With few changes, it developed into the Winchester lever action, so popular with hunters today. The arm had a high rate of fire, great range and accuracy, and was short enough for cavalry. But Ripley said "they cost too much," so only 731 were bought. Volunteers who bought their own brought the number used to 10,000.

"Much of the ever-growing interest in the Civil War stems from the fact that it was the first industrial war, the first railway war, the first telegraph war. Not all realize that it also was the first rifle war—the first war in which the rifle became the nearly universal weapon of the infantry."

One is reminded of the artillery general at the height of Gettysburg who rebuked a battery commander who appealed for more rounds: "Young man, do you realize that each time you fire one gun its costs the Government $2.67?"

In 1953, nearly 2,000 rounds of hand-loaded ammunition were expended in extensive tests to see exactly what the various Civil War rifles would do. The tests proved that the long and short model Enfields were a little more accurate at 100 and 400 yards than the Springfields, and quite notably so at the crucial antifield-gun range of 1,000 yards.

The short Enfield was a variant well worthy of note. Though light and compact (its barrel was barely twenty-four inches) it far outranged all carbines and equaled most rifles. After 1862, it became the only shoulder arm of Nathan Bedford Forrest's mounted infantry.

Forrest enjoyed four to six months' formal education, amassed a million dollars, raised his own troops, proved himself the greatest weapons genius of contemporary field commanders, and finally drove Sherman to the dictum—"that devil Forrest must be hunted down if it costs 10,000 lives and breaks the Federal Treasury!" Union Brig. Gen. William Sooey Smith declared his repeating carbines "helpless against Forrest's rifles."

Special sniper rifles were few in number but of real effect. Confederate troops competed by corps and they were given to the best shots in the Army. In 1863, thirty Whitworths were imported. Very heavy hexagonal-bored barrels with telescopic sights brought their weight to more than 30 pounds. Of caliber .451, their superb accuracy extended to 1,800 yards.

GENERAL Sedgewick was killed at Spottsylvania by Sergeant Grace of the 4th Georgia—probably the first bullet to be linked to the exact rifle that had fired it—at 800 yards' distance.

In the West, Cleburne's snipers were so effective and dreaded that they were dubbed "the executioners." They used twenty Whitworth and ten Kerr rifles. Union troops used a number of Morgan James rifles, similar to the Whitworths, but of round bore.

Union cavalry were far better armed than most of their opponents, using 94,000 Spencers, 80,000 Sharps, and 225,000 other breechloaders. Southern horsemen bore some thousand Sharps, but muzzle-loading carbines were general, and double shotguns were popular.

The revolver was the universal sidearm of cavalry and line officers. Some gunners were lucky enough to get them, and they not infrequently saved guns from capture. Always in short supply, they became a choice prize of every battlefield. Morgan's raiders used the revolver as their sole weapon. Each carried two in his belt and four on the saddle; one detachable stock fitted all guns (Colts, Remingtons, and Whitneys).

Colt furnished the U. S. with 386,000, Remington with 130,000, and 12 other makes brought the total to 750,000. A mere 10,000 were made in the South, but imports and captures served far better. Scant proof can be offered, but the total probably topped 300,000. Army revolvers were caliber .44, Navy .36.

The typical revolver weighed 2½ pounds with an 8-inch barrel. Paper, linen, or skin cartridges held 30 grains of powder and 216 grains of lead; separate percussion caps were usual. Largest was the LeMat, with an 8-shot cylinder, through the axis of which a caliber .60 shot cartridge was discharged. Smallest was the S.&W., caliber .22 short rim fire.

Nearly 100,000 hand grenades were issued during the war. That they are so seldom mentioned is excusable, for they seem to have been as dangerous to the pitcher as to the catcher! One type was a fin-stabilized torpedo of one, three, and five pounds; the other was an iron bomb, studded with fourteen caps and encased in a 2-piece cover!

Several machine guns appeared, though none were used to any extent. The Requa Battery had twenty-five parallel barrels, mounted on a field-gun carriage; the Agar "coffee mill" was hopper-fed to a single barrel. The Gatling, the only one to survive the war and later prosper, used six crank-rotated barrels. All used steel chargers with separate caps. Lack of weapons imagination killed all interest at that time, but the hand-cranked Gatling bothered our troops in Korea, and the power-driven Vulcan (a Gatling) now spits 6,000 projectiles a minute from our fighter planes.

FIELD guns issued to Union forces totaled 7,892. The South seemed to have acquired some 4,000 to 5,000 by seizure, capture, import, and manufacture—the latter being of very good quality. Field guns of 1861 were much impoved over those of the Mexican War. Napoleons and 10-pounder rifles were replacing the 6-pounder gun and 12-pounder howitzer.

All were of greater range, and ignition had progressed from the slow match to the Army friction primer and Navy percussion-lock. Breechloaders and built-up tubes appeared. Shell, which had been restricted to howitzers now (thanks largely to the bold innovation of the Russian fleet at Cape Sinope) was fired from all types.

But there were grave limitations: black powder, a fair propellant, usually burst shell into only four or five fragments; sights were crude; time fuzes unreliable; worst of all, Minié fire kept field guns beyond their optimum range. How much this last affected tactics by keeping artillery's prime role the defensive, is shown by the emergence of the Napoleon as the dominant fieldpiece of the last two years of the war.

To understand why it won over the more "efficient" rifle, let us critically examine this key weapon. The M1857 gun-howitzer was a compromise between the too-heavy gun and the too-short-ranged howitzer. It fired solid roundshot, shell, shrapnel, and canister —the killing projectile of the Civil War. So did the rifle—but not as heavy canister nor with such force.

The Napoleon's 4.62-inch bore just took larger canister than did the 3-inch rifle; moreover, the 2½-pound charge to the rifle's one pound enabled doubling or even tripling the canister for each shot. Disrupting at the muzzle, each canister spewed its 27 heavy balls in a lethal cone for 400 yards, with ghastly effect on attacking infantry.

Many excellent tables of Civil War artillery show weight of tube alone—not the complete gun. To the Napoleon's 1,227-pound tube should be added a 736-pound carriage and 392-pound wheels, so that the 6-man crew returned 2,355 pounds to battery after each discharge. On the march, a limber, 32 rounds, and tools added up to a weight of 3,865 pounds for the 6-horse team.

Each caisson and limber with 96 rounds made a 3,811-pound load for another team, while 3 men rode each of 4 ammunition chests and all nigh-horses carried a man. Most rifles had lighter carriages, for they used much less powder and had lighter recoil.

The cast-iron Parrott, despite its shrunk-on breech reenforcement, was a brittle piece, the larger sizes being subject to bursting in heavy use, but the 10-pounder was quite popular.

Best of the rifled guns was the 3-inch Ordnance (or Rodman) rifle. Made by wrapping boiler plate around a mandrel, welding, machining, and boring, its slim tube acquired great strength. Simple and handy, it was the choice of most horse artillery. Forrest made it his only fieldpiece, and with it he subdued Union gunboats!

Whitworth breechloaders had hexagonal bores and screw-breech closure. The 12-pounder had a routine range of 2,800 yards, 2¼ miles was reached with great accuracy, and 5 miles was possible. Its long bolts and shell were precisely machined to fit the 2.75-inch bore and were lubricated by pads of wax and grease.

THE most advanced weapon of the artillery, was the Williams automatic cannon. Spherical one-pound shell with self-consuming cartridges were hopper-fed to a reciprocating breech and fired through a steel barrel of 1.57-inch bore. A rate of fire of 65 shots a minute was reached but, to avoid overheating, firing was restricted to short bursts. At Seven Pines it reached 2,000 yards' range. Tredegar, Lynchburg, and Mobile made forty-two of these remarkable guns.

Though the 24-pounder Coehorn mortar was portable, it appeared as "field artillery" very late in the war. At Vicksburg, Grant's men, desperate for small mortars, made them of gumwood hooped with iron. That Grant was ordnance-minded was indicated by the appearance of eight Coehorns at the Wilderness in 1864.

The Coehorn proved to be of great value tactically. On its wooden bed it weighed 296 pounds, and 4 men carried it. Shell of 17 pounds ranged from 25 to 1,000 yards by varying the powder charge from half an ounce to half a pound. It has been called "key arm of the last nine months of the war."

NAVY ordnance was a mixture of the old and the new. Seagoing ships favored smoothbore guns for their long-range ricochet fire. Dahlgren 11- and 15-inch smoothbores were standard for turrets, but many Parrott rifles were on gunboats and ships. Variety of armament was shown by the famous CARONDOLET, which carried three 9-inch and four 8-inch smoothbores, one 30-, one 50-, and two 100-pounder rifles.

The MINNESOTA carried one 8-inch Parrott and one 11-inch smoothbore in pivot, four 100-pounder rifles, forty-two 9-inch smoothbores, and four howitzers in broadside.

Armor, torpedoes, and submersibles were the naval innovations. Ship armor started (in American practice) with the C.S.S. VIRGINIA and the U.S.S. MONITOR and soon spread to most rams and gunboats and to all Monitor types. The Confederate Army adapted armor to land use.

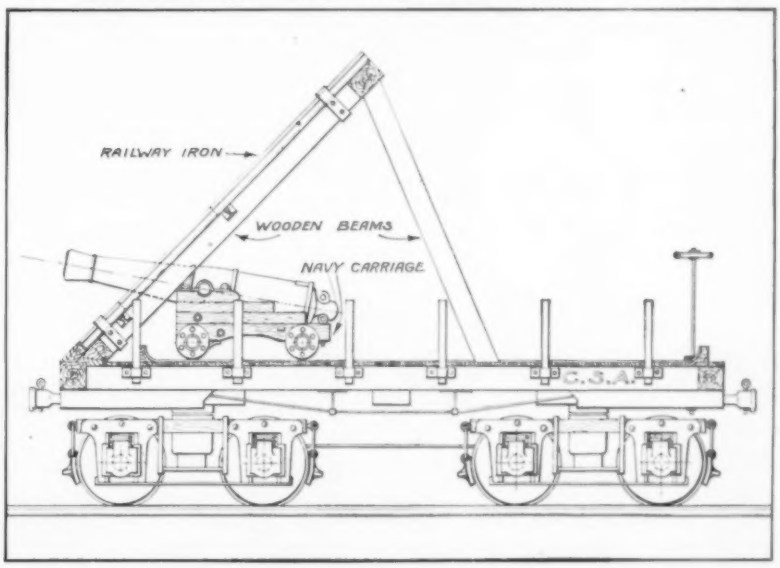
The first railway gun in history was suggested by General Lee, supplied by Confederate Navy Ordnance, and used at Savage's Station. Carried on a flatcar, a Navy 32-pounder rifled gun on Navy carriage threw a lead-coated "James" shell of about 50 pounds from its 6.4-inch bore to 1,900 yards. A sloping shield of railway iron protected gun and crew.

Civil War torpedoes would be termed "mines" today. Most of them, floating or anchored, carried 50 to 100 pounds of powder and were exploded on contact by percussion cap or acid.

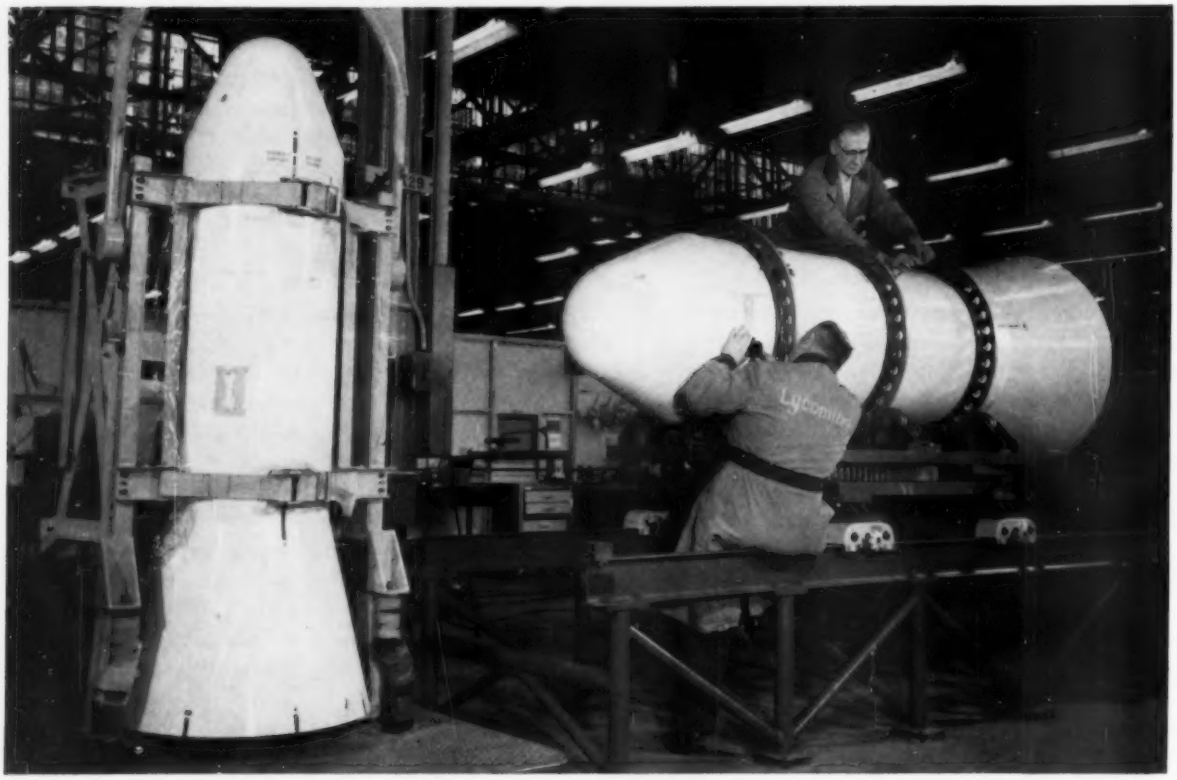
Spar torpedoes were on long poles affixed to the bow of a launch or submersible, and were fired by contact or by lanyard. Two Confederate submersibles used spar torpedoes to sink the HOUSATONIC and damage the NEW IRONSIDES at Charleston. Thirty vessels sunk and eight damaged testify to the effectiveness of the torpedo.

ONLY five days before Appomattox, Lee's hungry troops reached the railway at Amelia Courthouse. No bread or beef awaited them. But Josiah Gorgas' parting gift to the Army of Northern Virginia—redemption of his pledge of eighteen years before—was there: two cars of ammunition plus ninety-six filled caissons—"enough ordnance, on the spot, and on time!"

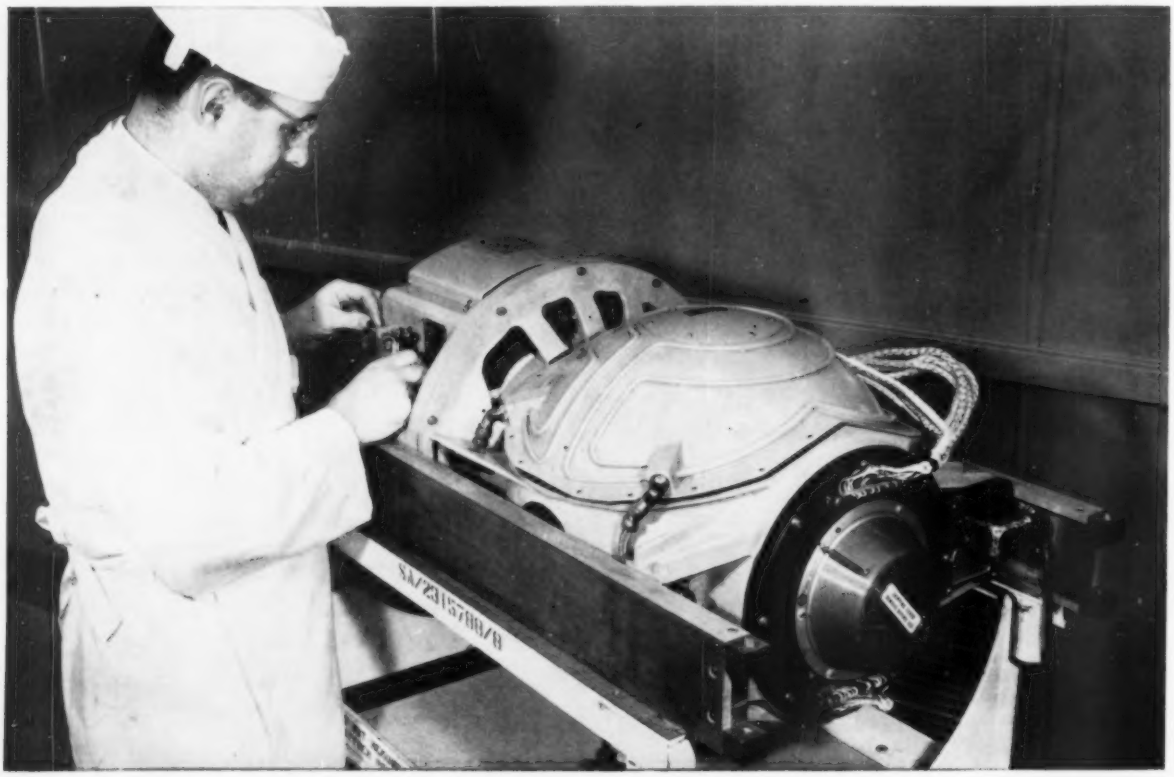
Confederate 32-pounder railway gun used at Savage's Station, Va., in June 1862.



Testing Missile Components



The RVX3 reentry vehicle for the Titan ICBM, left above, and the RVX4, right, are inspected at Avco Corporation's Lycoming Division before shipment to Cape Canaveral. Below, the Mark 1 inertial guidance system for the Polaris missile is checked by a General Electric technician. It contains gyroscopes, accelerometers, and its own electronic computer.



Defense Highlights: Monthly Review and Outlook

• **A Separate Supply Service?**—The Army's technical services are under fire again, this time by one of the numerous Defense Department task forces. Once again researchers and analysts are hammering at military logistics and procurement. And military leaders are worried that the need for wartime effectiveness will be overlooked in the smug neatness of an organization that appears commercially businesslike and economical in this so-called period of peace.

The study task force is finding it also must consider the entire Army administrative establishment from the Secretary of the Army down through research and reserve organizations in order to reevaluate the operations of the technical services. From this study some predict that the idea of a fourth service for supply may be dragged in again.

The "fourth-service concept" was proposed by a Hoover Commission committee and later by a congressional committee, in each case it was soundly criticized by military men who rightfully persisted that supply is not an independent function. Supply must be organized to give the greatest possible support to the fighting arms and it cannot be effective under detached civilian control.

The Army and the other services are hopeful that fighting efficiency will receive the necessary emphasis because combat-experienced officers are assigned to the task force that is restudying this already well studied matter.

• **The New Warfare.**—Maj. Gen. J. F. C. Fuller, noted British soldier, author, and historian, recently made the following timely statement:

"As I see things, the danger today is that armaments are being developed at such a pace that they are apt to obscure the problem we are called upon to solve, which is, as it always has been, a twofold one: To deter the outbreak of war by threatening war and, in the event of its outbreak, to win at the lowest cost.

"What distinguishes the present from the past is that, while in former times these two aims were complementary—the greater the power to deter, the greater the power to win—now they are antagonistic, because the power to deter is so enormous that, when unleashed, winning means mutual destruction.

"The outcome is that the more the power of armaments is developed the less becomes the possibility of solving the second half of the problem by means of them. Therefore, other means must be substituted in order to compel the enemy to change his policy. These, I hold, must be sought in the economic and psychological fields. To get the whole problem into focus needs a *total* outlook on war."

The September-October issue of ORDNANCE will contain an article by General Fuller who has been a regular contributor to the pages of this magazine for more than three decades.

• **Nuclear Power Progress.**—A hopeful forecast for two nuclear devices that will advance the conquest of space was made recently by Dr. Glenn T. Seaborg, Chairman of the Atomic Energy Commission. He reported to an A.O.A. meeting in San Francisco on the progress of a nuclear rocket (the Rover program) and of nuclear devices for generating auxiliary power.

A nuclear rocket, he noted, could attain specific impulses of 800 pounds of thrust per pound of propellant flow per second, whereas chemical propellants, now giving about 300 pounds can be increased to 475 pounds' thrust at the most. The weight of propellant can be greatly reduced compared with a chemical rocket, permitting larger payloads or longer flights provided the engine and shield weight are not excessive.

The first phase of the Rover program included three experimental nonflying Kiwi-A reactors that obtained good efficiency with gaseous hydrogen. A Kiwi-B series now under development will test use of liquid hydrogen and further confirm safety factors.

In expectation of success with Kiwi-B, the joint AEC-NASA Space Nuclear Propulsion Office that directs the Rover program is evaluating proposals from industry for a complete nuclear engine for rocket vechicle application (Nerva). Dr. Seaborg expects the first flight in the 1966-1967 period after extensive ground testing and consolidation of the reactor with the engine and engine with the vehicle.

In a search for small power units to operate transmitters and other auxiliaries, the AEC has been experimenting with small systems for nuclear auxiliary power (the SNAP program).

There are over a dozen SNAP devices, with the even-numbered ones using compact reactors to drive turbogenerators that energize thermionic converters, and the odd-numbered devices employing heat from radioisotope decay to generate electricity in thermionic converters.

The principal design criterion is long-term reliability to sustain transmitter power for five years or more for orbiting communication satellites or on long space voyages.

It is feasible now to put a SNAP 3 thermoelectric generator in a satellite. Also scheduled for fall delivery are four SNAP units fueled with strontium 90 to be used by the Navy and Coast Guard in remote navigational aids and weather stations. Two will produce 5 watts, the other two 30 watts.

There are widespread prospects for the use of SNAP reactors not only in all remote stations and to operate spare

vehicle equipment but also to propel rockets in space once they are clear of the earth's gravitational field.

Throughout all their developments the AEC Chairman pointed out that the "tough questions" involved safety in case of accidents in launching and disposition of waste nuclear matter in space.

• **Directions for Limited Warfare.**—To give limited warfare more status, the office of the Assistant Director for Limited Warfare Systems has been established by the Defense Director for Research and Engineering, Dr. Harold Brown. The new office combines the functions of the former Assistant Directors for Naval Weapons and Tactical Weapons.

Over-all responsibilities of the new office include activities in the fields of sea combat, antisubmarine warfare, fleet air defense, amphibious and land combat, mobility, logistics, guerrilla, counterguerrilla and tactical warfare systems, and related phases of tactical warfare.

Frank A. Parker, formerly serving as Assistant Director for Naval Weapons, has been named to head the new office.

So far much talk but very little money has been requested for the needed increase in the limited-war capability of the United States.

• **The Satellite Go-Round.**—The development of earth-orbiting satellites is progressing steadily in governmental circles but is encountering storms in the arena of commercial communications.

American Telephone and Telegraph Company's proposal to develop a commercial satellite communication system aroused the interest of some aircraft (aerospace!) companies and General Electric Company. The latter exhibited its own mock-up of a proposed relay satellite and formed Communications Satellites, Inc., as a covering organization to push its project and clamored to have a part in the communications program.

Lockheed Aircraft Company, as spokesman for the aerospace industry, demanded part ownership in the program.

After arguments before the Department of Justice, the Federal Communications Commission decreed that a joint commercial satellite system including international communication common carriers but excluding aerospace companies would be in the best public interest.

In the meantime NASA has ordered the Radio Corporation of America to start work on Relay, an active communication repeater satellite that could be tested within a year. Relay will be adaptable for military or commercial use.

The weather satellite, Tiros II, has been so successful that plans are under consideration for establishing a weather satellite network under the Weather Bureau. Even the Russian meteorologists, who suspect that Tiros may be a "spy vehicle" are showing an interest in a worldwide cooperative system of weather photographing in the outer atmosphere.

Tiros II, over six months in orbit, continues to transmit useful data. Tiros III launching is scheduled for this summer in time to catch the hurricanes.

Discoverer satellites and the Midas and Samos reconnaissance satellite programs have been removed from public discussion. They should be progressing smoothly since additional funds were appropriated. However, before any reconnaissance satellite can be of maximum use, better optics for clearer observations are needed. The Air Force Reconnaissance Laboratory near Dayton is seeking improved optics to give a resolution of 5 feet on the ground from 200 miles' altitude and new radiation-resistant emulsions for photographic work. It also is encouraging thermoplastic and electrostatic tape recording developments as alternatives to recording on emulsified films.

• **New Missile Trackers.**—More flexibility in missile and satellite launching trajectories will be available to the Atlantic Missile Range at Cape Canaveral when two seaborne tracking ships are put into service.

Two 11,000-ton troop-carrier ships (C-4 hulls) will be equipped under Air Force orders with the most up-to-date navigation, tracking, telemetering, and data-handling devices. This will enable AMR to fill in tracking gaps in the south Atlantic above Ascension Island or to use trajectories other than those now passing over their present island stations.

• **Project Artemis Progress.**—The Navy may crack the long-range submarine detection problem through Project Artemis started several years ago. The Office of Naval Research directs a program to evaluate the transmission of sound under water for great distances within a belt of equal thermal properties. A detection station, "Argua Island," was built in 200 feet of water south of Bermuda and the tanker, MISSION CAPISTRANO, was fitted with a towering sonar transducer and special power source. This is presumed to be for transmitting test signals.

A recent announcement of the sailing of the ship and other items about the experiment brought a flurry of accusations that "The Pentagon is giving away secrets—and in this era of general silence on military projects!"

The answer—You can't hide the massive equipment in the tanker and furthermore nothing classified has been revealed about the Artemis Project (See New Developments).

• **New Saturn Configuration.**—Modifications in the configuration of the Saturn launch vehicle were announced recently by the National Aeronautics and Space Administration.

A 2-stage Saturn C-1 will be used for the first ten research and development flights instead of the three stages originally planned. In the first several flights, however, a dummy third stage will be added for aerodynamic stability. The vehicle will be about 160 feet high.

Primary purpose of the first ten flights of Saturn, under development by NASA's Marshall Space Flight Center, is to test the vehicle. On the last four of the Saturn C-1 flights, as a secondary mission, early boiler-plate models of the Apollo spacecraft may be placed in earth orbit. It has been determined that a 2-stage Saturn C-1 will be able to accomplish the Apollo earth orbital mission.

The payload capability for a 2-stage Saturn C-1 will be about 20,000 pounds in low earth orbit.

Weapons for Limited War

An Editorial

AMID all the confusion of tongues existing these days about the status and plans for our defense posture and organization, it is well to review quietly a few of the basic principles which are well established. These guidelines have been set by experience; to flout them would be folly.

We do not refer here to our position on the stage of inernational relations. Sad to relate, that worsens hourly. Rather our concern is for our ability to win a war, especially a limited war—the only type of war fought during the past fifteen years, yet the kind of war that continues to change the face of the globe.

Amid all the studies, analyses, and rumors now rampant, we will be wise to take a cold, hard look at some basic tenets respecting our weapons preparedness.

In the area of unconventional strength we have, admittedly, an arsenal of vast power. We can retaliate gigantically if the need arises. But these nuclear weapons are of an earlier generation; they are not being modernized for optimum efficiency. Foolishly, we continue to waste priceless time in "negotiating" with the Communists about a nuclear test ban. Already we have lost more than two years while the "negotiations" continue on and on and on. Our statesmen are of inexhaustible patience. We pray that their forebearance will not be the cause of our national doom.

In the realm of weapons for limited war—the kind of conflict in which the Communists have made their greatest gains—our plight is a sorry one. Here's why we believe this to be the fact, and it is a belief based on the experience of World War I, World War II, and Korea—the life span of the Ordnance Association. That cumulative experience has proved that we can do everything connected with war—from brush-fire to all-out—faster than we can produce the modern weapons needed to wage such a conflict.

In the First World War the period required for maximum weapons production was eighteen months. Twenty years later, in the Second World War, the period was shrunk to twelve months—thanks largely to early productive efforts of Lend-Lease operations. Both that phase of the war and the total production effort relied entirely upon the cooperation of American industry and the ordnance organizations of the Army and Navy.

The Korean War, closely following World War II, relied upon the older weapons, and partial mobilization was responsible for a slowdown in the delivery of modern armament.

THERE are reasons aplenty why the record is as it is. Forty years ago we were a sleepy, smug, pacifistic people who would have little or nothing to do with preparedness. With war raging in Europe as late as 1916, our national policy forbade any semblance of weapons readiness. It was *time* that was lost, and this loss was later translated into loss of lives. We were eighteen months late!

A score of years later the stage had been set by belligerent pacifists for our lost time in the Second World War. The dismal, disgraceful record of the roaring 'twenties and the foolhardy 'thirties affords no solace but only shame. Again, we lost priceless time.

By reason of an infinitesimal interest in weapons by our people—American science and industry included—we repeated the cycle of two decades earlier but reduced the running time: we were twelve months late.

And so with Korea. Although but five years had passed since the greatest mobilization of all recorded history, we believe a fair estimate would be that we had whittled the running time to weapons readiness by only a few months.

All these experiences proved again that we can recruit, clothe, house, and train men faster than we can design and produce all the weapons of all the types we need for full military effect.

Now, nuclear weapons have moved the timetable even of limited war to zero. Now instant readiness is essential. The most modern weapons of superior quality and adequate quantity must be in being to meet the given case. What with worldwide military commitments growing out of our mutual security pacts with more than threescore nations, the kinds and quantities of weapons required range from the simplest to the most complex.

THE other facet of this problem relates to the cost of instant readiness in terms of dollars. Who is so naïve as to say that cost reduction, waste elimination, and simplification of types and of organization are not of prime consideration? They are, beyond doubt. Cost reduction must be prosecuted with vigor and ceaseless determination on every front. So must the prevention of waste and duplication and the creation of an efficient organization—these are areas where firmness is not only desirable but mandatory.

But, over and above all else, our weapons must be better than those of an enemy, and they must be in readiness. All else is secondary—unless we are at the head of the class, we have expelled ourselves from this school.

So the simplicities bring us back to where we started. Instant weapons readiness is essential. It is costly in money. If we do not pay the price in dollars now we may pay it later in men.

Weapons for limited war must always be in being for the simple reason, as experience shows, that we can appropriate money until every last dollar is confiscated from every citizen—but we cannot appropriate a single minute of time.

These are the simplicities of the case based on experience. Are we smart enough to have learned from three failures in one generation?

ASSOCIATION AFFAIRS

Navy Is Host To A.O.A. Members At Forty-Third Meeting On West Coast

The triennial seagoing assembly of the Association, its Forty-third Annual Meeting, will be remembered for many years by all the 800 members who participated. They were treated to an excellent seminar on naval weapons developments, and later they were embarked in five ships of an imposing task force of the First Fleet where they were introduced to the very best in Navy hospitality.

The outstanding nature of all the sessions was made possible by the encouragement of Secretary of the Navy John B. Connally, Jr., Chief of Naval Operations Adm. Arleigh A. Burke, and Commander in Chief, Pacific Fleet, Adm. John H. Sides.

The Association deeply appreciates their interest and cooperation and the hard work and thoughtful planning of the many officers of the Fleet who were directly involved in the sessions and who are named in this record.

The program for the first session on Tuesday, May 16th, was held at the Statler Hilton Hotel, Los Angeles, Calif., under the auspices of the Los Angeles Post. Sessions began with a Sea Power Luncheon that was addressed by Vice Adm. Charles L. Melson, Commander, First Fleet. The admiral's address appears on page 36 of this issue.

Frank Mayer, president of the Los Angeles Post, presided and opened the meeting with a welcome on behalf of the Post, host for the meeting to all members and to the Navy guests.

During the forenoon, A.O.A. staff members, ably assisted by members of the Los Angeles Post, arranged for the assignment to ships and helped with transportation problems for the day-at-sea session.

The afternoon was devoted to a seminar on "Naval Armament in the Missile Age." The Golden State Room of the Statler was packed to its capacity of 600. Presiding officer was Col. Henry N. Marsh, vice-president for Technical Divisions and Sections of the A.O.A., and the chairman was Vice Adm. Willard A. Kitts, 3rd, deputy chairman of the Association's Underwater Ordnance Division, who introduced the speakers. Also at the speakers' table were Mr. Mayer and Everett Baugh, general chairman of the Association's Technical Divisions.

Col. E. E. Teeporten of the Puget Sound Post, left, presents an A.O.A plaque to Comdr. M. E. Bustard, commander of the U.S.S. KING, in appreciation for sea trip.

Rear Adm. Henry L. Miller, Commander, Carrier Division 15, led off with a presentation of "Antisubmarine Warfare Weapons and Tactics" in which he explored the wide variations in armaments that must be mutually supporting in order to outwit undersea attacks. His remarks appear on page 153.

Frank J. Bednarz, assistant director, Polaris missile program, Lockheed Aircraft Corporation, treated the audience to an account of the development, testing, and production of Polaris as seen from industry's point of view. His talk was based on an excellent series of slides that showed testing of the major components, production sequences, and scenes of handling and loading the missile into a submarine.

His slides also showed the widespread industrial and Navy ordnance facilities involved in the project from the Naval Ordnance Test Station's "pop-up" tester on San Clemente Island off California to the Naval Shipyard at Portsmouth, N. H., where launch testing vehicles were tried out.

Mr. Bednarz's presentation indicated how it was possible to compress the time schedule several years through the use of numerous simulators and scale models before a submarine was available. The most elaborate of these devices were the motion-simulating launcher at Cape Canaveral and the merchant ship, OBSERVATION ISLAND, fitted with a complete Polaris launching system.

On the industry side of the Polaris team working for Lockheed are 134 subcontractors, 757 large vendors, and 3,970 small vendors. The largest subcontractors are Aerojet-General Corporation, Hercules Powder Company, General Electric Company, and Nortronics Division of Northrop Corporation.

In conclusion, Mr. Bednarz explained the workings of the Performance Evaluation Review Technique (PERT), a management system that has enabled the Industry-Navy Polaris Team to meet the extra demands of the recently accelerated Polaris program without excessive strain.

Brig. Gen. Samuel R. Shaw, U.S.M.C., Commanding General, Landing Force Training Unit, Amphibious Training Command, wove together skillfully the tasks of the Navy, Marine Corps, and Army in developing the equipment for am-

phibious operations. In his discussion the general used visual aids to show some of the new weapons, helicopters, craft, and vehicles that are needed to give an amphibious assault speed and firepower. His discussion appears on page 39.

Rear Adm. Jack P. Monroe, Commander, Pacific Missile Range, gave a most comprehensive illustrated talk on the facilities at the Pacific Missile Range. It is the most recently established of the three "national" ranges that also include the Atlantic Missile Range at Cape Canaveral, Fla., and the White Sands Missile Range, N. Mex.

The admiral noted that the three ranges give the United States sufficient test and satellite launching facility as far into the future as we can see and that there were very few overlapping functions.

He explained in crisp detail the capabilities of the four ranges in the Pacific Missile Range complex: (1) a sea range to conduct air-to-air and other short-range missile tests; (2) a polar satellite range for launching devices such as Discoverer; (3) a ballistic-missile range equipped to handle intermediate missiles such as Thor or the ICBM's, Atlas, Titan, and Minuteman; and (4) an antimissile range that will be connected with Kwajalein Island to test the Nike Zeus.

He said that his range is prepared to establish an equatorial range when required. This would permit equatorial orbits that would be the simplest for a rendezvous in space for refueling, changing crews, or building a space station.

In conclusion the admiral said: "The Pacific Missile Range is essentially completed now, but no range is ever finished. Projects are always in the process of phasing onto the range or phasing off. Each major project generally requires new facilities of some type or another. Therefore the range operator must be very flexible, very cost-conscious, and must use mobile equipment to the maximum and build as few permanent sites as possible.

"I look forward with confidence to the Pacific Missile Range providing an ever-increasing amount of support to our missile, satellite, and space projects, using the great span of the Pacific Ocean to the maximum. I can assure each prospective user that he will find an enthusiastic 'Can Do' attitude from our personnel."

The Forty-third Annual Dinner Meeting was significant as the first event at which J. E. Trainer, the recently elected president of the Association, addressed a national meeting and as the occasion for presenting the Adm. W. H. P. Blandy gold medal to Rear Adm. P. D. Stroop, Chief, Bureau of Naval Weapons, the guest of honor.

Mr. Mayer, able president of the Los Angeles Post, presided and announced the playing of the National Anthem to open the meeting. Immediately thereafter Rear Adm. E. B. Harp, Chaplain of the 11th Naval District, delivered a stirring invocation.

Mr. Mayer welcomed the members on behalf of the Post and read letters of welcome from Earle Brown, Governor of California, and Norris Poulson, Mayor of Los Angeles and a director of the Post.

MR. TRAINER as toastmaster spoke on behalf of the entire membership in expressing his appreciation to the Navy saying, "We of the Ordnance Association are proud to work closely with the Navy and to support its weapons responsibilities to the best of our ability and energy."

He then called on the audience for special recognition of Admiral Melson for his coordination of the naval demonstration and assistance in all the sessions. Rear Adm. Thomas F. Connolly, Commander, Carrier Division 7, was introduced as the host for the next day and gave a brief account of the program. He also pointed to the flexibility of a naval task force that could exert influence overseas in any proportion from a friendly liberty party to a swarm of nuclear-armed attack jet aircraft.

Mr. Trainer, in reviewing the role of the A.O.A., said: "The degree of understanding which exists between industry and the military is the real measure of our ability to defend ourselves in this nuclear age. Unless there is complete understanding and cooperation between these forces, instant readiness is weakened and the needs of war cannot be met. We of the Ordnance Association are pledged to the principle that industry and the military must fully cooperate at all times, working hand in hand.

"The record of the past half century proves, beyond a doubt, that the lack of armament readiness not only jeopardizes victory, but the costs in time, lives, and money are frightful. Wisdom and prudence demand that whenever we must again defend ourselves against a ruthless foe, we must have weapons superior to his, ample in quantity, and ready for instant use.

"The Ordnance Association is devoted to this purpose and is proud to share this vital responsibility with the armed forces."

Col. Henry N. Marsh, a national vice-president, and Col. Herbert R. White, a regional vice-president of the Association, came to the center of the dais with Admiral Stroop to present to him the Association's Admiral Blandy gold medal. Colonel Marsh read the citation that states in part, "a profound student of naval warfare, his sound judgment and keen insight have helped to ensure that the Navy's armament programs and tactics are correlated for the maximum battle efficiency of our naval forces." Colonel White presented the medal to Admiral Stroop.

The admiral, after expressing his appreciation, made a special point of recognizing Lieut. Gen. John H. Hinrichs, Chief of Army Ordnance, who was at the speakers' table and explaining how the two Chiefs worked closely together in mutual support to produce superior weapons. He then described the efforts being made by his Bureau to keep down weapon costs. His address is printed on page 42.

"Man the buses" was the word passed at 5:15 a.m. at the Statler Hotel on May 17th. Members, in warm jackets and wearing their "admiral's caps" specially provided for the occasion, were embussed and under way at 5:30 a.m. By 6:30 a.m. all hands were boarding their assigned ships: the carrier RANGER (CVA 61), anchored out, and, at the Long Beach Naval Station piers, the heavy cruiser HELENA (CA 75), the missile cruiser PROVIDENCE (CLG 6), and the missile frigates KING (DLG 10) and MAHAN (DLG 11).

Under way and clear of Long Beach harbor, Task Force 10.4 picked up its destroyer antisubmarine screen consisting of the PERKINS (DDR 877), SWENSON (DD 729), F. B. PARKS (DD 884), BLUE (DD 744), COLLETT (DD 730), and CRAIG (DD 885). Enroute to the first operating area a hearty Navy-style breakfast was served.

Contact with the submarine, BONEFISH (SS 582) was announced about mid-forenoon and all hands lay up topsides to see her evolutions. There was an excellent broadcast circuit from Admiral Connolly's flagship, RANGER, to all ships so that each ship's announcer was kept informed directly of events in progress.

The BONEFISH, a conventionally powered ALBACORE-type submarine, ran through the formation on the surface so that all could admire her whalelike shape, made a crash dive, fired rockets to simulate a torpedo attack, and made a high-angle emergency surfacing. During the submarine's performance, the task force continued to steam southwest at high speed under overcast skies.

THROUGHOUT the day the members, divided into small groups, were guided through all the ships' spaces while the equipment and its operation were explained.

As the ceiling failed to lift, the antisubmarine-warfare events were pushed ahead in the schedule while the task force ships closed into a tight formation so that all could see. In rapid succession MAHAN fired an Asroc antisubmarine weapon carrying an inert depth charge; SWENSON

and PERKINS launched salvos of Hedgehog underwater contact charges: and PARKS and CRAIG dropped patterns of depth charges that produced underwater shock waves apparent in all the ships present.

It was not until late afternoon that the task force commander ordered planes to be launched, although the poor visibility required the aircraft to fly on instruments. Again the formation closed in toward the RANGER while F8U, A4D, and FJ-4 aircraft were catapulted or flown off, disappeared in the overcast, and were then recovered.

Several times the formation speed was increased to 31 knots ("just like Arleigh Burke," said the announcer) in desperate attempts to find a clear area for firing tests of the Regulus, Terrier, Bullpup, and Sidewinder missiles, to conduct bombing and strafing by aircraft, and to hold an antiaircraft practice by the destroyers and cruisers.

However the weather failed to cooperate, but in spite of disappointment over not completing all the exercises the Navy's guests were enthusiastic about the opportunity to be at sea with such an impressive task force and they will always remember the unsurpassed hospitality of the officers and men in each ship.

Col. E. E. Tepoorten of the Puget Sound Post, a life member, showed his appreciation for the day's experience by presenting an A.O.A. plaque to the KING in which he was embarked on May 17th. The KING proceeded to Seattle immediately after disembarking its guests.

The colonel flew home, hurriedly had an inscription for the plaque made, and was on the dock with Puget Sound Post President Lee Ketchum to present the plaque.

The inscription reads: "To the officers and men of the U.S.S. KING (DLG 10) in appreciation of a mission 'Well Done,' May 17, 1961."

The planning and conduct of this memorable meeting could not have been accomplished so smoothly if there had not been the effective support of Los Angeles Post officials led by Frank Mayer. His principal assistants were Rear Adm. John B. Pearson, chairman of the reception committee; Richard Cowden, chairman of the transportation committee; Robert W. Reniers, Robert Q. Parsons, and a host of other energetic members.

AEC Chairman Seaborg Is Honor Guest At San Francisco Post Spring Meeting

The San Francisco Post's annual spring luncheon meeting was held on May 10th at the Fairmont Hotel, San Francisco, Calif. A large crowd of industrialists and engineers of the A.O.A. were assembled to welcome the guest speaker, Glenn T. Seaborg, Chairman of the Atomic Energy Commission.

Elmer R. Peterson, president of the Post, conducted the meeting, welcomed the members, and introduced the guest of honor. Earlier he had presented the A.O.A.'s certificate of appreciation and Bronze Medallion to Col. Dean Witter for more than two decades of outstanding service as a patriot. Colonel Witter held every local and regional office in a long career of A.O.A. service.

Chairman Seaborg expressed his theme in the statement, "On the basis of present scientific knowledge, I believe that nuclear propulsion could provide the most feasible means of accomplishing long voyages in space."

He described the progress being made in two programs that will make his prediction possible—Rover, nuclear reactors for rocket propulsion, and SNAP systems for nuclear auxiliary power.

The content of his talk is of such general interest that it is summarized in Defense Highlights on page 67 of this issue.

In conclusion Chairman Seaborg said: "Mankind is only on the verge of the Space Age. Nuclear rocket propulsion aided by nuclear-powered instrumentation will carry us a long stride forward into the vast universe that surrounds this little earth."

Mr. Peterson announced the following officers and new directors of the Post: President, Elmer R. Peterson; vice-presidents, Willis M. Hawkins, Jr., and Walter J. Maytham; secretary-treasurer, Col. W. F. Meany, and directors, R. M. Cook, C. O. Lindeman, and R. H. Gerdes.

Other guests at the speakers' table were: Chaplain H. H. Heuer, Sixth United States Army Chaplain; Vice Adm. F. N. Kivette, U. S. Naval Defense Forces, Eastern Pacific, Western Sea Frontier, and Pacific Reserve Fleet; Lieut. Gen. R. M. Cannon, Commanding General, Sixth United States Army.

Also, Mr. Maytham, vice-president, San Francisco Post; Mr. Hawkins, vice-president, San Francisco Post; Col. John M. Stark, regional vice-president and director, San Francisco Post; L. S. Fletcher, National Council representative, San Francisco Post; Colonel Meany, secretary-treasurer, San Francisco Post, and the following directors:

W. E. Hoard, Western Gear Corporation; E. Finley Carter, Stanford Research Institute; W. E. Butts, General Metals Corporation; M. Kendrick, Schlage Lock Company; Mr. Lindeman, Pacific Telephone & Telegraph Company; and W. E. Waste, Bechtel Corporation.

Attending the San Francisco meeting are, left to right: Lieut. Gen. Robert M. Cannon, Commanding General, Sixth Army; Dr. Glenn T. Seaborg, Chairman, Atomic Energy Commission; Elmer R. Peterson, Post president; Vice Adm. F. N. Kivette, Commander, Western Sea Frontier; and Brig. Gen. R. F. Bromiley, Commander, Travis Air Force Base. Dr. Seaborg was guest of honor and principal speaker.

Capt. W. C. Bennett Speaks To Florida Post Members On Undersea Mine Warfare

A dinner meeting of the Florida Post was held at the Eglin Air Force Base Officers' Club on March 20th with Col. Herbert M. West, Post president, presiding. At a brief business session the treasurer's report was received and plans discussed for future meetings.

Colonel West introduced the guest speaker of the evening, Capt. W. C. Bennett, U.S.N., Commander, U. S. Naval Mine Defense Laboratory, Panama City, Fla., who gave a most interesting presentation on the "Conquest of Inner Space."

Highlights of his speech included a discussion of the mission and facilities of the Mine Defense Laboratory and the history of mine warfare. He expounded

on the need for oceanographic research to supplement the present meager knowledge of "inner space"—the canyons, mountains, and continental shelves of the ocean floor and waves, tides, and currents such as the warm Gulf Stream and the cold Humboldt current. Captain Bennett described ocean exploration by means of bathyscaphs such as the TRIESTE and described the ocean's reserves of food, minerals, and oil as yet untapped.

In decrying our lack of seagoing research ships (we have only about forty-five whereas the Soviets have over one hundred) he outlined the proposed Navy program, involving both basic and applied research, designed to regain leadership, create break-throughs in oceanography, and lift the "iron curtain of ignorance."

Secretary Richard S. Morse Addresses April Meeting Of The Washington Post

The April luncheon meeting of the Washington Post drew more than 400 members and guests to welcome Assistant Secretary of the Army for Research and Development Hon. Richard S. Morse.

The presiding officer, M. C. Richmond, Post president, prior to presenting the distinguished guest speaker, introduced the Secretary of the Army, Hon. Elvis J. Stahr, Jr., a surprise member of the audience. Others at the speakers' table were:

Hon. James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development; John B. Macauley, Special Assistant to the Director of Defense, Research and Engineering; Dr. Edward G. Witting, Deputy Assistant Secretary of the Army for Research and Development; Brig. Gen. B. A. Hockmuth, Deputy Chief of Staff, Research and Development, U. S. Marine Corps Headquarters; Brig. Gen. C. W. Clarke, Assistant Chief of Army Ordnance, Research and Development.

Also, Ned O. Kraft and W. E. Haines, vice-presidents, Washington Post; and W. J. Reed, Post secretary-treasurer.

Dr. Morse brought to light the efforts in the Defense Department for closer collaboration among the services in their research and development efforts. He noted that in addition to the usual interchange of formal program specifications, the principal research and development officials of all the services meet weekly at luncheon to explore new scientific finds and to explain any recent changes in their programs.

He made a plea for closer exchanges among the scientists and scientific laboratories of industry. Dr. Morse stated the Nation's scientific effort was being diluted and even wasted in some fields because of the lack of interchange and because too often industrial scientists failed to observe the whole picture due to interest in their own company's products.

Secretary Morse also pointed out the need for greater care and patience in explaining the research and development problems to congressmen and budgeteers who are not versed in scientific language.

Missiles And Astronautics Division Holds Meeting At Point Mugu, Calif.

Increasing coordination with Government agencies and the ever-improving responsiveness of Division papers submitted to answer Government problems featured reports given at the spring meeting of the Missiles and Astronautics Division, Point Mugu, Calif., on April 19th and 20th.

Reports received by Jesse M. Hadley, Bendix Corporation, Washington, D. C., chairman of the Division, emphasized the gratification of the Ordnance Corps and the Air Force that these informative and timely data had been received on such diverse subjects as infrared, reliability, and maintainability problems.

Among those at Missiles and Astronautics Division meeting were, left to right: C. L. Eksergian, Division chairman emeritus; Rear Adm. M. F. Schoeffel, U.S.N. (Ret.), deputy chairman; Maj. Gen. W. O. Senter, Headquarters, U.S.A.F.; Rear Adm. J. P. Monroe, Commander, Pacific Missile Range; Jesse M. Hadley, Division chairman; Col. Henry N. Marsh, A.O.A. vice-president for Divisions; Brig. Gen. J. G. Zierdt, Commander, Army Rocket & Guided Missile Agency; Rear Adm. J. M. Jaap, Office, CNO.

Some 175 members and consultants of the Division met at the call of Chairman Hadley. The Pacific Missile Range (PMR), Rear Adm. Jack P. Monroe, Commanding, was host for the meeting, and Elmer P. Wheaton, Douglas Aircraft Company, Santa Monica, Calif., Division deputy chairman, was the meeting manager.

The session opened with greetings from Admiral Monroe and the receipt of reports noted above as well as reports of activities of the National Academy of Sciences and the A.O.A.'s Value Engineering and Technical Publications Committees.

The program continued with briefings by Rear Adm. J. M. Jaap, Office Chief of Naval Operations (OpNav) Washington, D. C.; Capt. D. F. Welch, U.S.N., of the same office; Comdr. L. J. Stecher, Navy Bureau of Ships, Washington, D. C.; and Capt. P. C. Rooney, U.S.N., also of OpNav.

Maj. Gen. W. O. Senter, Headquarters, U.S.A.F., Washington, D. C., presented some of the problems of procuring aerospace systems. Brig. Gen. John G. Zierdt, Commander, Army Rocket and Guided Missile Agency, Huntsville, Ala., concluded the morning session with a discussion of the Nike Zeus system.

The afternoon sessions were devoted to separate Section meetings where appropriate technical papers were presented by Government, scientific, and industrial personnel.

After dinner, Admiral Monroe spoke to the Division members and to some 175 members of the Los Angeles Post, A.O.A. His subject was "Defense in the Space Age," and was particularly well received by the combined group of A.O.A. members.

On April 20th, the meeting attendees were briefed on PMR activities of the three services. The members then toured the facilities of PMR, including the Aerology Building which receives data from the Tiros weather satellite.

Although a final decision could not be made at this time, discussion indicated the desirability of holding the next meeting with the Air Force, probably in the northeastern part of the country.

In conjunction with this meeting Mr.

Wheaton presented a substantial check to Admiral Monroe out of surplus from the Meeting. The donation was made payable to the U. S. Navy Relief Society.

Mr. Wheaton also presented a similar donation to Brig. Gen. John T. Honeycutt, Commander, 47th Artillery Brigade, Fort MacArthur, Calif., as a gesture of appreciation for the support of the U. S. Army which furnished bus transportation for the Division's meeting. At General Honeycutt's request, this check was made payable to the Youth Activities Committee at Fort MacArthur.

New York Post Sponsors Discussion Of Navy Weapons At Town Hall Meeting

The New York Post held the second in a program of three technical meetings at Town Hall, New York City, on the evening of April 25th. Devoted to the Navy weapons program, the meeting was attended by over 850 members, their guests, and Reserve officers of all the services.

The guest speakers and their subjects were: Rear Adm. William A. Schoech, Deputy Chief, Bureau of Naval Weapons, "Today's Naval Weapons Systems"; Capt. John H. McQuilkin, Director of Ship Design, Bureau of Ships, "The Nuclear-Powered Navy"; Capt. Albert S. Freedman, Jr., Director of Quality Management, Bureau of Naval Weapons, "Value Improvement Program of the Bureau of Naval Weapons"; and Frampton E. Ellis, Jr., Assistant Director of Weapons Systems Analysis, Bureau of Naval Weapons, "Future Naval Weapons Systems."

At New York Post Town Hall meeting are, l. to r.: F. E. Ellis, Jr., Bureau of Naval Weapons; Capt. A. S. Freedman, Jr., Bureau of Naval Weapons; Col. J. W. Graham, Post secretary-treasurer; Rear Adm. W. A. Schoech, Deputy Chief, Bureau of Naval Weapons; W. L. O'Donovan, Post vice-president; Capt. J. H. McQuilkin, Navy Bureau of Ships; and Col. Gordon L. Barclay, Chief, Information Section, First Army.

A feature of the meeting was "The Log of the Triton," a color film of the first around-the-world underwater voyage of a nuclear submarine. A second film, "PERT Break-through," explained the successful employment of the Program Evaluation Report Technique by the Bureau of Naval Weapons Special Projects Division.

Admiral Schoech's presentation included a discussion of the entire range of modern naval weapons—ships, aircraft, mines, torpedoes, bombs, and missiles, demonstrating that today's Navy has the capability to fight a limited or an unlimited war.

Captain McQuilkin discussed in detail the development of the nuclear submarine, beginning with the NAUTILUS authorized by Congress in the fiscal 1951 shipbuilding program. To date, the over-all program includes forty-eight nuclear submarines, seventeen of which are already in operation. In concluding, the speaker said:

"As you can see, this nuclear Navy is one of considerable complexity, almost unlimited in endurance and great offensive power. As a matter of fact, these fifty-one ships that constitute the current nuclear Navy, either in being or under construction, pack a punch which far exceeds that of all of the armadas of all of the contestants of World War II. It is an excellent example of the Navy's theme of 'Nuclear Power for Peace.'"

In emphasizing the Navy's determination to obtain more weapons for the same number of dollars in spite of rising costs, Captain Freedman outlined the steps which have been taken toward this end by the Navy in cooperation with its contractors. These include establishment of a value-improvement program, intensification of the value-engineering effort, establishment of a data-requirements committee, and implementation of reliability and quality-control procedures.

Concentrating primarily upon the future weapons systems of the Navy, Mr. Ellis explained the basic warfare missions of the Navy which are: strike, antiair, antisubmarine, amphibious, and support. The weapons for these missions that will be emphasized in the future are manned aircraft, missiles, and spacecraft. These weapons will be employed in various "mixes" for each type of warfare mission.

Col. Lloyd W. Stearns, a director of the New York Post, presided at the technical meeting and introduced the speakers. The technical session was preceded by a reception and dinner at the New York University Club where William L. O'Donovan, vice-president, New York Post presided.

In addition to the guest speakers, those attending included: Rear Adm. F. L. Hetter, Commanding Officer, Naval Supply Center, Bayonne, N. J.; Capt. E. G. Sanderson, Commanding Officer, Naval Ammunition Depot, Earle, N. J.; Col. G. L. Barclay, Chief, Information Section, First U. S. Army; Comdr. F. B. Dillon, Commanding Officer, Naval Ordnance Reserve Company; Comdr. W. Goodspeed, Supply Officer, 3rd Naval District; Col. John W. Graham, secretary-treasurer, and Edgar F. Luckenbach, third vice-president, New York Post.

Welding Section Committee Attacks Problems Of The Ordnance Missile Command

A strong attack upon specific welding problems of the Army Ordnance Missile Command dominated the meeting of the Steering Committee of the Welding Section, Production Techniques Division, at Redstone Arsenal, Ala., on February 28 and March 1, 1961.

Convened by Section Chairman Harry L. Ingram, Air Reduction Company, Washington, D. C., the Steering Committee heard problems presented by Lieut. E. J. Wilson, Jr., Army Rocket and Guided Missile Agency (ARGMA), and Julian S. Kobler, Army Ballistic Missile Agency. During this phase of the meeting, Henry Handler, Office, Chief of Ordnance, Washington, D. C., presided.

Detailed discussion, suggestions, and recommendations of the Committee were offered to the Defense agencies on (1) automatically following a tightly butted seam weld, (2) spot welding of heavy aluminum sections, (3) stress-relieving welds in T-1 steel structures, and (4) weldment specifications to incorporate design, fabrication, and inspection requirements.

A technical paper, "A New Concept of Weldability as Related to High-Strength

Steels," was presented by Mr. Kobler and was the basis of extensive technical discussion. The committee later witnessed a film on ARGMA's Nike Zeus program, as well as inspecting the Army Ordnance Missile Command facilities at Redstone Arsenal.

Final Luncheon Meeting Of Washington Post Is Addressed By Brig. Gen. M. B. Adams

On May 18th the Washington Post concluded its 1960-1961 series of monthly luncheon meetings with Brig. Gen. Milton B. Adams, Deputy Director, Aerospace Systems Development, U. S. Air Force, as guest of honor and guest speaker. Millard C. Richmond, Post president, introduced the many distinguished guests at the speakers' table including:

Hon. James G. Fulton, 27th Congressional District of Pennsylvania; Hon. George P. Miller, 8th Congressional District of California; Don R. Jackson, Deputy Assistant Secretary of the Air Force, Matériel; Hon. Abraham Hyatt, Director, Program Planning and Evaluation, NASA.

Also, Maj. Gen. A. H. Luehman, Director of Information, U.S.A.F. Headquarters; Rear Adm. Francis D. Foley, Assistant Chief for Program Management, Bureau of Naval Weapons; Maj. Gen. Robert E. L. Eaton, Assistant Chief of Staff for Reserve Forces, U.S.A.F. Headquarters; Maj. Gen. Richmond M. Montgomery, Assistant Vice Chief of Staff, U.S.A.F. Headquarters; Brig. Gen. D. C. Lewis, Director, Special Weapons, Office, Chief of Staff, U. S. Army.

General Adams spoke on "Space: How Can We Get There?" He reminded the audience that we are entering a new environment even before we have learned to live peaceably on earth. Therefore we must be determined to prevent the use of space exploration to further earth's quarrels.

"The current conflict," he said, "is not amenable to the mass-production techniques nor the hard-and-fast policies of the past. It puts a premium on imagination, quality, originality, and flexibility, all bonded together with a compound of determination and faith."

The general explained the relation of the Air Force in space matters with the Defense Department, Director of Research and Engineering, and within the National Aeronautics and Space Administration, and noted that assigned to NASA are seventy-eight Air Force, seventeen Navy, and fifteen Army personnel.

On the basis that "every responsible American should know more about our national space program regardless of who in the Government is concerned with any particular program element," the general showed an excellent film that outlined the objectives and the problems of space exploration and explained clearly space-age phraseology.

Mr. Richmond announced the following officers and new directors who were to take office on July 1st. William E. Haines, president; Ned O. Kraft, first vice-president; Wilbur J. Reed, second vice-president; Philip L. Sommer, secretary-treasurer; and Directors W. R. F. Adams, Col. Walter B. Brown, Rear Adm. Francis D. Foley, J. B. Hall, C. W. Hayes, and Peter MacDonald.

Comdr. T. R. Rhees Discusses Polaris At Meeting Of The Panhandle Chapter

The spring meeting of the Panhandle Chapter, Mid-Continent Post, featured a dinner and presentation by Comdr. Thomas R. Rhees, staff aide of Vice Adm. William F. Raborn, Director, Special Projects, Navy Department. About one-hundred members and guests assembled at the Herring Hotel in Amarillo, Tex., for the affair held on April 26th.

Chapter President Milton E. Shaw as presiding officer called on the executive vice-president of the Chapter, M. J. Bruedigam, to read the A.O.A. preamble. Other officers present were: R. B. Carroll and W. D. Forsha, vice-presidents; B. O. Jacobsen, treasurer; W. R. Rollen, secretary; and J. C. Drummond, National Council representative.

Milton E. Shaw, outgoing president of the Panhandle Chapter, presents charter and gavel to I. B. Akst, new Chapter president, as Marvin J. Bruedigam, Pantex Ordnance Plant, Amarillo, Tex., executive vice-president, looks on. The presentation occurred at the spring meeting of the Chapter held at Amarillo.

Commander Rhees gave an interesting, informative, and graphic talk on the subject of the Polaris missile, consisting of a brief discussion of the present world situation, national defense, and the changing role of sea power, particularly the impact of the ballistic missile.

He emphasized the fact that the Polaris, which is already capable of being fired from underwater to targets on any continent, will soon be capable of reaching any spot on earth. He stated that one submarine carrying sixteen Polaris missiles has more destructive power than all the bombs dropped during World War II, including the two atomic bombs. Use of the Navy missile is especially effective, he said, because of the submarine's mobility and concealment factors.

The commander's commentary was supplemented by color slides, and the presentation was concluded with a short movie showing the Polaris in action, including actual scenes taken aboard the nuclear submarine, the GEORGE WASHINGTON, on the historic day in July 1960 when the first ballistic missile was launched from a submarine beneath the surface.

At a business session a new slate of officers proposed by the nominating committee chaired by M. R. Hill was elected by acclamation. They are: I. B. Akst, president; Marvin J. Bruedigam, executive vice-president; W. R. Campbell, Rue Hestand, Robert Tyldesley, and M. L. Ott, vice-presidents; John Custer, secretary; and S. F. Murdock, treasurer.

(*Continued on p. 77*)

Communications equipment for combat areas. Newest compact, FM communications equipment for the U. S. Army Signal Supply Equipment Agency is Avco's VRC-12, designed and produced by Avco's Electronics and Ordnance Division. It uses narrow-band FM, covers 30-70 megacycles, has 920 channels, either manual or automatic tuning. It is one-seventh the size, two-thirds the weight of former equipment. And it is completely compatible with manpack or airborne FM radio now being developed by the Army.

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Gen. C. D. Eddleman Addresses Chicago Post Meeting On "Modern Military Strength"

Gen. Clyde D. Eddleman, Vice Chief of Staff, U. S. Army, was the guest of honor at the Chicago Post's annual dinner meeting on May 10th. In attendance in the Red Lacquer Room of the Palmer House, Chicago, Ill., were over 500 members and guests. H. J. Prebensen, Post president, as presiding officer welcomed the members and called on Col. John Slezak to introduce the guest of honor.

General Eddleman, an outstanding authority on world military affairs, spoke on "Modern Military Strength," relating our needs to the ever-increasing threat of the Communists to use their growing military power to shape events to their own design.

He said that the United States must be able to deter or respond to a thermonuclear attack and must provide balanced and capable land, sea, and air forces "which can engage and defeat the forces of our potential enemies in any form of war, nuclear or nonnuclear."

Army photo

Gen. Clyde D. Eddleman, Vice Chief of Staff, U. S. Army, center, was speaker at Chicago Post meeting. With him are Lieut. Gen. E. L. Cummings, Fifth Army, left, and Post President H. J. Prebensen.

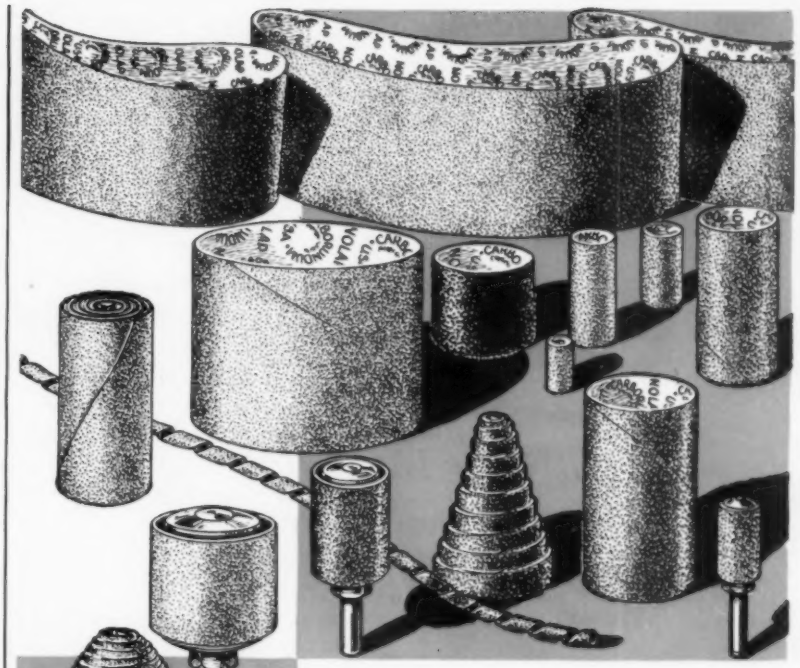
Another requirement which must receive new emphasis is for improved capabilities to combat the subversion and guerrilla warfare which constantly threaten the stability of small nations throughout the world.

He pointed out that insurrection is only one phase of the Communist military strategy for achieving world domination and said that limited, nonnuclear wars now appear to be "the most likely forms of active conflict."

General Eddleman also called for a strategic air and sea lift to "project and sustain our military strength abroad—together with the means to protect air and sea lanes from enemy attack."

Guests at the speakers' table were: Lieut. Gen. E. L. Cummings, Commanding General, Fifth U. S. Army; Rear Adm. J. M. Higgins, Commandant, Ninth Naval District; Maj. Gen. A. R. Fitch, U.S.A., Deputy Assistant Chief of Staff, Intelligence; Brig. Gen. E. J. Gibson,

(*Continued on p. 78*)



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Commanding General, U. S. Army Ordnance Weapons Command; Brig. Gen. J. A. Heintges, U.S.A., Director, Organization and Training.

Also, Brig. Gen. C. W. Clark, Chief, Research and Development, Office, Chief of Army Ordnance; Lieut. Col. William H. Sparrow, Commanding Officer, Chicago Ordnance District; Col. J. T. Sheridan, Chief, Mid-West Office of Information, Office of the Secretary of the Air Force; Col. Leo A. Codd, executive vice-president, A.O.A.

Also, E. J. O'Keefe, G. D. Dearlove, and Z. C. R. Hansen, all vice-presidents of the Post; George Catlett, Post treasurer; and the following directors:

Francis Seng, Keith I. Parsons, James B. Rosser, T. L. Kelly, A. Pope Lancaster, William G. Swartchild, Jr., Bennett Archambault, S. H. Egbert, S. D. Moseley, Charles Z. Meyer, M. J. Allen, Louis Putze, Francis W. Parker, Jr., and John Browning. Also, Lieut. Col. Luther G. Schliesser, Chaplain, Fifth U. S. Army, who delivered the invocation.

General Schriever Is Guest Of Honor At Annual Meeting Of St. Louis Post

Gen. Bernard A. Schriever, Commander, Air Force Systems Command, was guest of honor at the St. Louis Post annual dinner meeting on May 17th. A distinguished assemblage of over 400 industrial, educational, and scientific leaders were present at the Sheraton-Jefferson Hotel to welcome the general. Post President Warren C. Drake, welcomed the members and guests and announced the officers for 1961-1962.

After presenting the newly elected president, Robert Charles of Universal Match Corporation, Mr. Drake introduced the guest of honor.

General Schriever's address, "A Force for Freedom," emphasized the need for the United States to maintain strong aerospace forces and for its citizens to have the will to defend their freedom.

After describing the rapid advances we have made in missiles and high-speed aircraft, the general noted the over-all mobilization of men, methods, and equipment in the Communist bloc to perpetuate their power.

"To meet this danger," he said, "it is evident that our strongest weapon—even in the space age—is the national will. This is the key to our deterrent strategy, for no weapon, even the most advanced, is any better than the men who wield it in combat.

"The fact that man has reached space may make it necessary for us to defend ourselves against attack from space. There are two missions that can be better performed in space," he said, "warning and communications," and he expressed faith in the Midas missile-warning satellite and the Army's Advent space communication system.

In conclusion General Schriever said the biggest challenge is to maintain an alert, flexible position that can respond quickly to new technologies.

"That is a tall order," he stated. "The fullest backing of the public is needed, for defense is the task of everyone. It takes money. It takes imagination. Many of the components of our missiles weren't even dreamed of a decade ago. Industry has had to meet demands for a whole new order of precision and reliability. And it takes vision. Our schools and colleges must educate our young people for intelligent and courageous living in the space age."

General Schomburg Amazes Members At Cincinnati Post Joint Dinner Meeting

Maj. Gen. August Schomburg, Commander, Army Ordnance Missile Command, Redstone Arsenal, Ala., was the guest of honor at a distinguished gathering of Cincinnati Post members and their ladies on April 20th. The affair was a dinner meeting held jointly with the Engineering Society of Cincinnati in the city's Music Hall.

Following the National Anthem, the Rev. Paul M. Vandegriff, minister of Armstrong Chapel, delivered the invocation. General Schomburg was introduced by Homer E. Lunken, Cincinnati Post president.

The general's message was one of simplicity—the simplicity sought by Army research teams in developing refined missile systems. At one point General Schomburg demonstrated with flaming gas in a darkened auditorium how future missiles may utilize the gas they produce to perform functions now carried out by complicated electronic equipment.

Radiating confidence in the ability of American missiles to meet any enemy challenge, he outlined development projects that may some day be incorporated in them. These included: A device which can scan a target, reply upon a memory cell to determine if it is hostile, and provide guidance resulting in destruction; a T-shaped key which tests the readiness of an Honest John rocket at the firing site, enabling one man to do in a few minutes what it once took a trained team fifteen man-hours to do.

Also demonstrated was a radio transmitter placed in a sphere which continued to send out its eerie "beep-beep" message even when it was bounced on the floor or rolled across the room. The general's point here was that microminiaturization inherently makes electronic devices more rugged, an ever-increasing requirement in the missile age.

He also showed a directional apparatus which keeps a missile on course as it proceeds to its target. This was illustrated by a blindfolded man who placed a ball in the catcher's mitt of an Ed Bailey cutout on the first try.

General Schomburg said: "We are spending $1.5 billion annually on Army missiles and ninety per cent of this work is contracted to American industry."

After telling the audience the Army has twenty-one missile systems in the field or under development, General Schomburg concluded his presentation with films showing Pershing surface-to-surface and experimental Nike Zeus surface-to-air missiles in action.

Foreign Small Arms Hold Limelight During Meeting Of Division At Fort Bragg

A report on foreign small-arms developments and a long-range forecast for U. S. small arms headed the list of papers presented at the meeting of the Small Arms

At Small Arms Division meeting, l. to r.: Chairman M. R. Warden and Maj. Gen., D. E. Beach, commanding the 82nd Airborne Division and acting head of STRAC.

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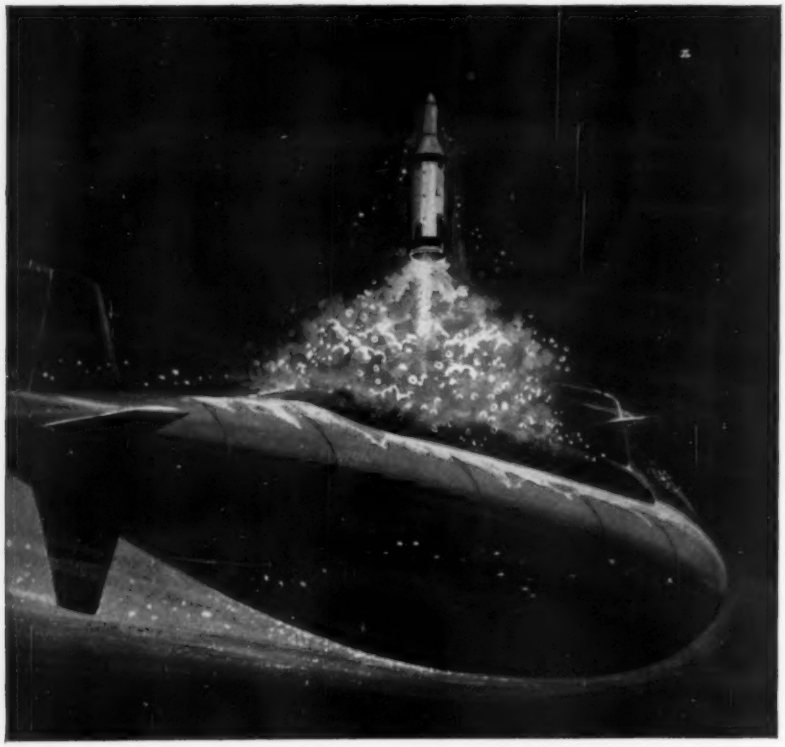

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Meeting at the call of Chairman Maxwell R. Warden, Remington Arms Company, Bridgeport, Conn., more than sixty members and consultants convened on March 21st. They were greeted by Maj. Gen. Dwight E. Beach, Commanding General, 82nd Airborne Division, and acting commander of the Strategic Army Corps.

Mr. Warden then turned the meeting over to Henry Handler, Office, Chief of Ordnance, Washington, D. C., who conducted the technical discussions.

Papers covering a broad scope of subjects pertinent to small arms were presented by Joseph P. Smith, Ordnance Technical Intelligence Agency, Washington, D. C.; William Smith, Ordnance Weapons Command, Rock Island Arsenal, Ill.; Otto von Lossnitzer, Springfield Armory, Mass.; Arthur Zaverilla, also of Springfield; C. Rhodes, Frankford Arsenal, Philadelphia, Pa.; J. W. Mitchell, also of Frankford; Col. C. L. P. Medinnis, commander of Springfield; B. Gerke, of the Weapons Command; and R. B. Bowie, Remington Arms Company, Bridgeport, Conn.

At dinner General Beach discussed the "Meaning and Mission of STRAC,"—a subject of unusual interest to the Division.

On March 22nd, inclement weather forced cancellation of the scheduled mass parachute jump by the 82nd Airborne Division. A film on airborne tests was presented prior to inspecting several of the facilities of the airborne units.

Following luncheon, the Sections of the Division held individual sessions after which the meeting adjourned.

Publications Committee Announces New Officers At Meeting In Washington

Chairman Chester W. Lytle of the Special Committee on Technical Publications announced new officers of the committee at its meeting in Washington, D. C., on April 26th.

Arthur G. Norris, Vitro Engineering Corporation, New York, N. Y., has been selected as the Committee deputy chairman. To facilitate communications, Mr. Lytle named John Hansell of the Washington office of the Lytle Corporation to be secretary and J. D. Givens of Albuquerque to be assistant secretary.

R. A. Johnstone, Allison Division, GMC, Indianapolis, Ind., was appointed chairman of the Subcommittee on Maintenance Publications. Dale A. Drenth, Ingersoll Division, Borg-Warner Corporation, Kalamazoo, Mich., was designated chairman

(*Continued on p. 83*)

Minuteman Transporter-Erector. Prime Contractor—Boeing Airplane Company, Seattle Wash. Missile Container—Military Div. of Cessna Aircraft Co., Wichita, Kansas. Tractor & Trailer—GMC Truck & Coach Div., Pontiac, Mich.

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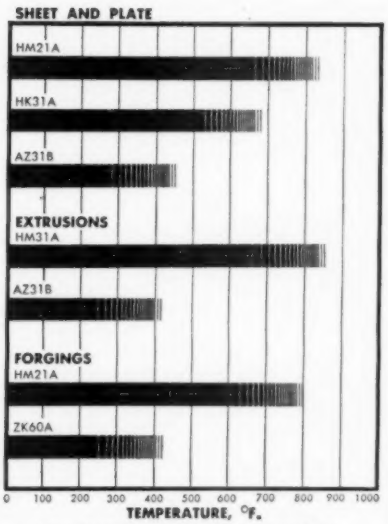

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of the Subcommittee on Operator Publications.

The Subcommittee on Supply Publications will be headed by Philip B. Lundstrom, Milmanco, Inc., Renton, Wash. Mr. Norris of Vitro also has been designated chairman of the Subcommittee on Training Publications.

S. W. Arwine, McLaughlin Research Corporation, Washington, D. C., will chair the ad hoc committee on Levels of Writing. The ad hoc committee on Reports will be under the leadership of J. D. Duffy, Cushing & Nevell, Inc., New York, N. Y.

Consultants from the services presented both general and specific problems currently being encountered by Defense agencies. A special presentation was given by W. W. Thomas, Radio Corporation of America, Moorestown, N. J., who is chairman of the Engineering Documentation Section, Production Techniques Division.

Mr. Thomas reviewed the experiences of his Section, recommended specific actions to facilitate the operation of the Technical Publications Committee, and cordially invited close cooperation and coordination between the Section and the Committee to obtain optimum results in these related fields.

After individual subcommittee meetings, the Committee tentatively set the dates of September 13th and 14th for the next meeting. The first day is planned to be a joint meeting with the Engineering Documentation Section at the invitation of Mr. Thomas. A more detailed agenda of the meeting will be announced later.

Richmond Chapter, Dixie Post, Receives Charter At Inaugural Meeting Of Group

The Richmond Chapter of the Dixie Post was chartered on Friday, May 26th, in an inaugural meeting at the William Byrd Hotel, Richmond, Va. A number of distinguished members of the Dixie Post led by their newly elected president, Col. L. C. Leonard, professor of mathematics, College of William and Mary, Williamsburg, Va., were present to welcome the new Chapter of the A.O.A. only 3½ years after the Dixie Post received its own charter.

Colonel Leonard called the meeting to order and asked Colonel Steiger, chairman of the new Chapter's nominating committee to present the slate of officers and directors. The nominations were unanimously approved, and Russell Scott, first vice-president of the Chapter, took the chair and introduced the guests at the speakers' table.

The officers and directors of the new Chapter are: T. L. Fritzlen, Reynolds Metals Company, president; Russell C. Scott, Experiment Incorporated, first vice-president; J. C. Byrne, Robertshaw-Fulton Controls, second vice-president; J. S. Mondy, Allied Chemical Corporation, third vice-president; and Capt. M. W. Clark, Reynolds Metals Company, secretary-treasurer.

The following are the new directors of the Chapter: W. T. Curdts, Flight Research, Inc.; Ernst Farley, Richmond Engineering; C. F. Manning, Reynolds Metals Company; Richmond P. Maury, William Byrd Press; J. W. Mullen, Experiment Incorporated; Albert Suttle, Petersburg, Va.; W. Monroe Wells, Reynolds Metals Company; R. L. Wherlie, Robertshaw-Fulton Controls; Col. Frank G. White, Commandant, Army Management Center; and F. D. Williams, Tredegar Company.

The charter was presented by Capt. J. M. P. Wright, A.O.A. headquarters, following a commentary on the mission of the Association and a word of welcome.

Dr. Ulysses Cormier, first vice-president of the Dixie Post, introduced Brig. Gen. Richard M. Hurst, Commanding General, Army Ballistic Missile Agency, Huntsville, Ala., the guest of honor and guest speaker.

General Hurst reminded the audience that the first attempt to fire a large rocket had been made by a Confederate engineer in 1865 who launched his missile from Richmond, aimed at Washington, but its impact was never determined. The war ended before he could try another shot.

He described briefly the rapid advances that have been made since 1865, especially during the past fifteen years, that have led to the Army's latest missile, the Pershing. Now, he said, almost half of the Army Ordnance expenditures are allocated to missiles.

To exhibit the Army's family of nineteen missile systems, the general showed a comprehensive color film that depicted all sizes of missiles and rockets from the M72 antitank weapon to the new Pershing and developmental Nike Zeus.

In concluding, General Hurst noted the outstanding cooperation that Army Ordnance receives through its Qualitative Developmental Requirements Information (QDRI) program and appealed for long-range planning by industry equal to that in the armed forces.

(*Continued on p. 88*)

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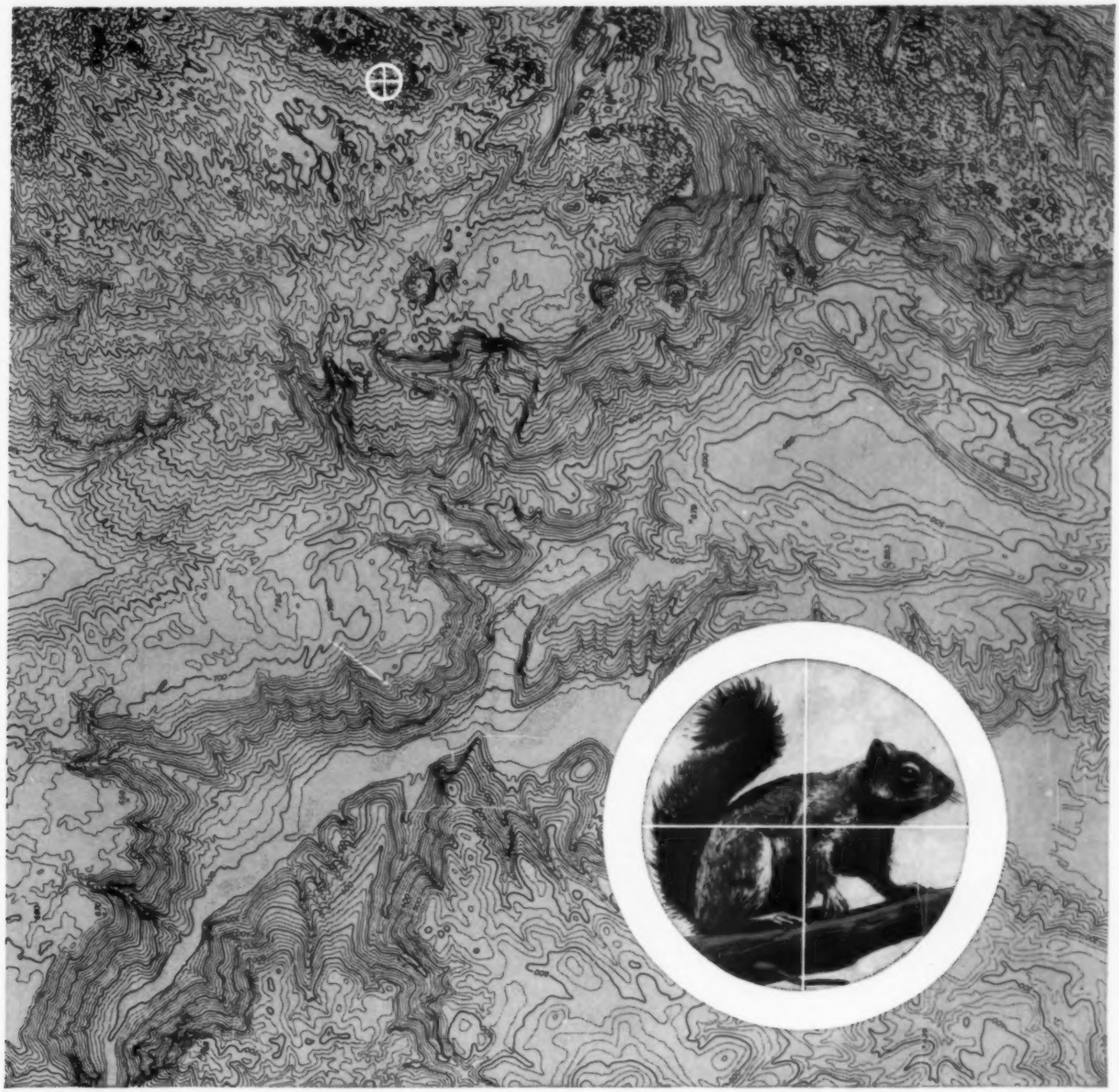

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PRODUCT Budd DEVELOPMENT

Checking performance of a nitrogen tetroxide OLFACTRON (center unit): Dr. R. R. Austin (right), with Mr. D. S. Barlow, Vice President (left), and Mr. L. M. Ballard (center) of the Instrument Division.

A Report from American Systems Incorporated...

Exotic Propellant Vapor Detection

As a major step in its program of developments for the aerospace field, American Systems Incorporated is introducing a new type of instrument for detection of toxic propellant vapors. Called OLFACTRONS because they act like an electrochemical "nose," quantitatively measuring vapors in amounts too slight to be detected by human senses, these instruments increase safety and effectiveness in handling high-energy propellants.

In the OLFACTRON principle, the vapor sensed produces a proportional electric current, which in turn is indicated on a meter, or recorded. The instruments are fast-acting, and can be integrated easily into electronic warning systems. OLFACTRONS are now available for detection of hydrazine, UDMH, nitrogen tetroxide, and borane. Similar instruments for detection of sulfur, hydrocarbons, and moisture are in production for the natural gas, LP gas, petrochemical, and chemical industries.

Developed by Dr. Robert R. Austin and Myron L. Robinson, in association with the Instrument Division of American Systems, OLFACTRONS illustrate the systems influence in practical instrumentation design. The instruments are adaptable to system networks involving communications, computation, and data processing.

Complementing the work of the Instrument Division, technical programs are under way in six other Divisions:

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Mathematical and statistical research; computer programming, and advanced programming systems; computation services; digital system studies; logical design; advanced systems analysis.

DATA PROCESSING

Data processing subsystems research and development; logic of command and control complexes; optical recognition systems.

ELECTROMAGNETIC SYSTEMS

Electromagnetic physics; electronic and mechanical scanning antenna systems; development and manufacturing of complete sensor systems and special microwave components.

RESEARCH LABORATORIES

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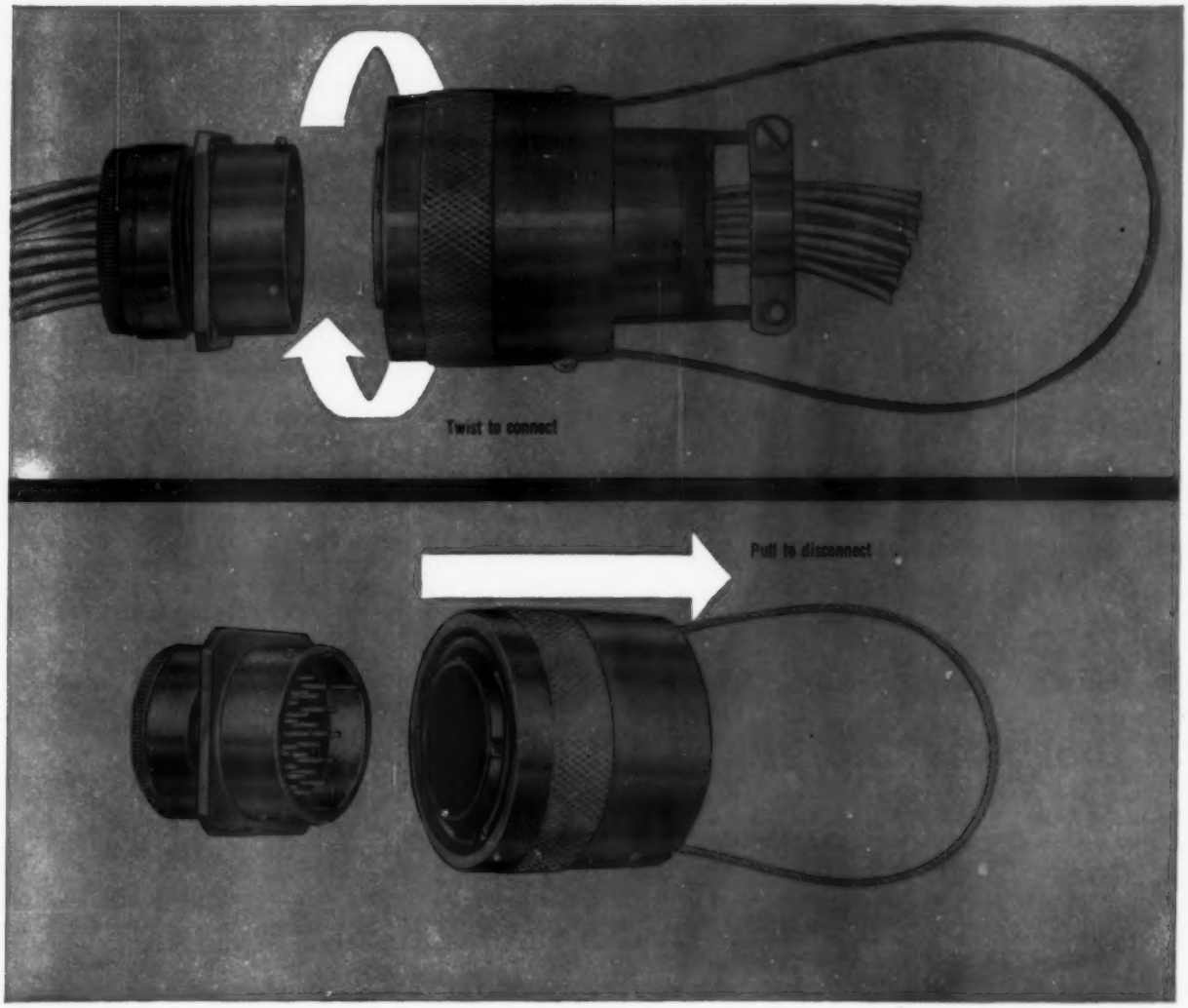

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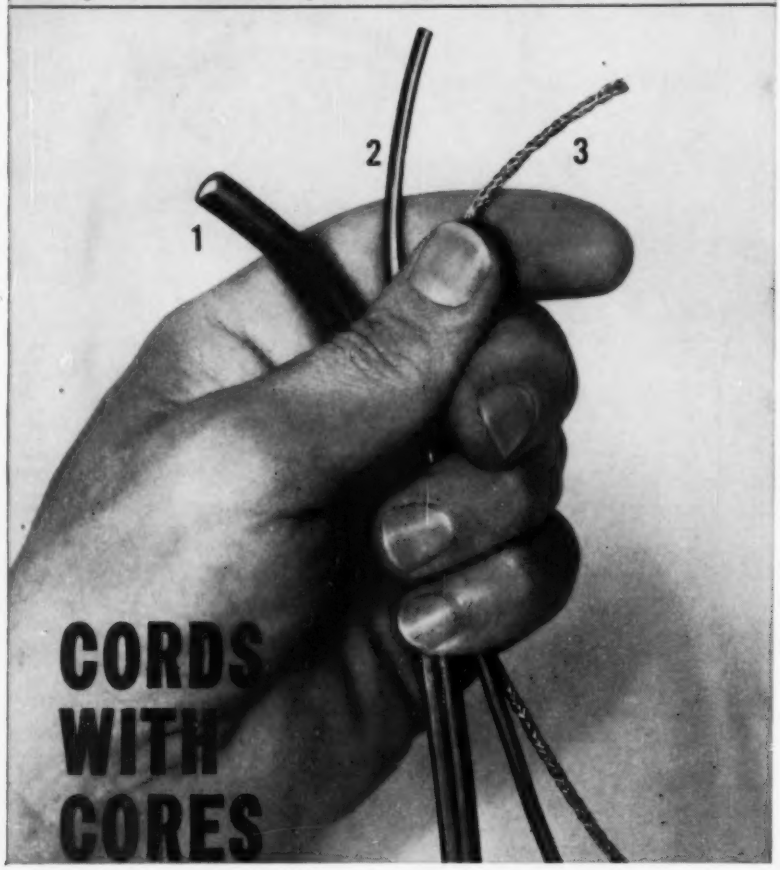

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Deflagrating Type

3. A versatile ignition device: Du Pont "Pyrocore," a flexible cord igniter, is a small diameter, continuous metal tubing containing a detonating-ignition core. Typical specifications are:

Outside Diameter: Range in Inches—0.051-0.105
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Approximate Velocity: Ft./Sec.—12,000-21,000

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BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*

Cumberland Valley Post Hears Admiral Metzger At Spring Dinner Meeting

Rear Adm. Edward F. Metzger, Assistant Chief, Bureau of Naval Weapons, Contracts, was guest speaker at the Cumberland Valley Post spring dinner meeting on May 4th. Members and guests totaling 120, representing all the industries of the area, gathered at the Officers' Club, Naval Supply Depot, Mechanicsburg, Pa.

Post President William Strauss presided and also delivered the invocation. Rear Adm. James B. Ricketts, commander of the Supply Depot, welcomed the guests to his activity and in announcing his forthcoming departure for California took the opportunity to say goodbye to his many friends present.

Capt. E. W. Sutherling, Post vice-president, introduced Admiral Metzger, a former shipmate.

The admiral gave an informal and straightforward talk on the importance of the "industrial specialist" company in weapons development. He explained that he favored this term in place of "small business" when discussing ordnance production, and noted that the small industrial plant had many advantages in that management was more familiar with their programs and had more flexibility in adopting new ideas during production processes. He added that the small organizations also operated on lower overhead costs.

"The Navy's viewpoint on this subject," he said, "is that the entire productive capacity of this country is required to support the strength of the Nation. This means that we must take advantage of the specialized facilities and skills of our entire economy. We must minimize the costs to the taxpayer for the defense effort. This means that we are constantly attempting to introduce new suppliers, to encourage new skills, and to maintain specialized facilities and specialized talent."

Admiral Metzger outlined the various means available to the small producer to keep abreast of defense requirements. He offered the following challenge to the industrial specialist:

"Our weaponry today is fantastically complex. There is application of a myriad of scientific disciplines in the defense program. Inside those disciplines there are production techniques which lend themselves to specialized development. I see no reason why application of initiative, talent, and hard work cannot enable small companies to participate effectively, either at the prime-contract or subcontract level, in the defense program."

Guests at the head table not previously mentioned were Brig. Gen. D. E. Break-

field, commanding general, Letterkenny Ordnance Depot; Capt. J. M. P. Wright, A.O.A. headquarters; and Brig. Gen. Robert W. Daniels, Chambersburg, Pa.

Engineering Documents Group Reviews Current Problems At New Orleans Meeting

The Steering Committee of the Engineering Documentation Section, Production Techniques Division, devoted its New Orleans meeting of March 14th to reviewing problems on hand and to the development of improved procedures for Section operations.

Led by Chairman W. W. Thomas, Radio Corporation of America, Moorestown, N. J., the discussion first focused upon several new military specifications and standards, a Defense data requirement study, and a draft of the DOD Standardization Program for fiscal years 1961, 1962, and 1963. Particular concern was expressed about a trend from MIL-D-70327 by some Government agencies.

To improve Section operations, rules of operation have been drafted and are under review. Further discussion covered subcommittee activities and controls; maintenance of membership lists; meeting schedules, programs and reports; and visitor control. A policy of establishing fees for meetings was adopted.

Karl G. Seipp, Philco Corporation, Philadelphia, Pa., volunteered and was designated the Section liaison representative to the Special Committee on Technical Publications.

General Schomburg Speaks At Annual Dinner Meeting Of Lone Star Post, Dallas

The Lone Star Post held its annual spring dinner meeting on March 17th at the Brookhaven Country Club, Dallas, Tex. The guest speaker was Maj. Gen. August Schomburg, Commanding General, U. S. Army Ordnance Missile Command, Redstone Arsenal, Ala. The 400 members and guests at this affair represented the greatest attendance in the history of the Lone Star Post for any meeting.

Post President Blake Caldwell presided and introduced General Schomburg who spoke on "Texas and Missiles." The talk presented the basic concepts under which the missile program is being developed. The status of the Army missile program was outlined and an idea of what we can expect in future developments was also

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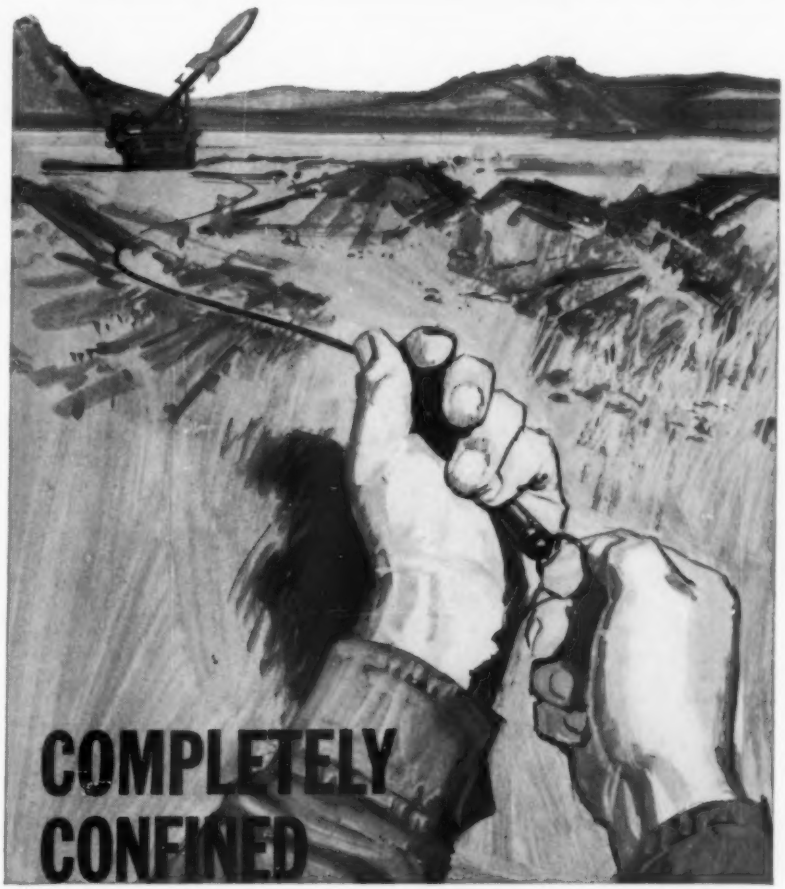

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presented. The presentation was vividly supported by action photographs of various missiles.

At the conclusion of General Schomburg's talk, he was made an honorary citizen of the State of Texas.

Guests at the head table were: Maj. Gen. Edward P. Mechling, A.O.A. national headquarters, Washington, D. C.; Col. J. W. Milner, Commanding Officer, 64th Artillery Group, Camp Walters, Mineral Wells, Tex.; Col. Gerald Johnson, Jr., Commanding Officer, U.S. Army Ordnance District, St. Louis, Mo.; Col. Moyers S. Shore, Commander, East Texas Sector, VIII Army Corps, Dallas; Lieut. Col. Arthur L. Travis, Dallas Subsector Commander, VIII Army Corps.

Also, Leo S. Bassett, senior representative, Dallas Regional Office, U. S. Army Ordnance District, St. Louis, Mo.; and Rev. G. J. Barras, S. J., who delivered the invocation.

• **THOMAS E. MURRAY**, a member of the Atomic Energy Commission during a crucial period in the Commission's existence, and an active member of the American Ordnance Association for many years, died in New York City on May 26, 1961. He was a member of the Association's Council.

During World War II as head of the Metropolitan Engineering Company, Mr. Murray won distinction in the design and production of mortar shell of superior quality and low cost.

Throughout his public life and since his retirement from the Commission in 1957 Mr. Murray had been an outspoken advocate of the continued development of nuclear weapons for United States forces. He placed great emphasis on small warheads in contradistinction to the annihilation types of larger weapons. He lost no opportunity to plead his cause and did so with facts, logic, and conviction which were characteristic of his entire life and work.

The son of Thomas Edward Murray, an associate of Thomas A. Edison, Mr. Murray inherited his father's inventive genius and engineering skill. A native of Albany, N. Y., he was graduated from Yale University with a degree in manufacturing engineering in 1911.

Mr. Murray held more than 200 patents, also emulating his father who was a pioneer in the early application of electrical energy. He succeeded his father as president of the Metropolitan Engineering Company and as board chairman of Thomas E. Murray, Inc. He later organized the Murray Manufacturing Company for the production of electrical switches. It was this company that established noteworthy records in the production of mortar shell.

Mr. Murray was always of deep religious faith and wide public interest. He acted as receiver of the Interborough Rapid Transit Company of New York City in 1932 and continued to serve in that capacity until the city took over the subways and elevated lines in 1940. This service he performed at the request of the late Judge Robert P. Patterson who later became Secretary of War.

In his plea for the lifting by the United States of its test ban on nuclear weapons, Mr. Murray addressed open letters to the two Presidential candidates last fall. He foretold a radically new type of nuclear weapon which would differ widely from its predecessors and insisted that irreplaceable time was being lost in dickering with a ruthless and uncompromising Communistic enemy.

The American Ordnance Association subscribes to Mr. Murray's views and itself has urged the immediate resumption of nuclear tests.

The Association mourns the death of an ideal citizen and loyal member whose talents were given without stint for God and country.

• **RICHARD F. WEBSTER**, secretary-treasurer of the Sporting Arms and Ammunition Manufacturers' Institute and of the Institute of Makers of Explosives died at Valley Stream, Long Island, N. Y., May 22, 1961. He was an active member of the Ordnance Association from World War II days when he served as a public information officer for the St. Louis Army Ordnance District with the rank of first lieutenant.

In 1952 he succeeded the late Maj. C. Stewart Comeaux as secretary of the two Institutes. Major Comeaux was a former president of the Association's New York Post.

Mr. Webster was also treasurer of the Wildlife Management Institute and a past president of the New York Society of Association Executives. His work for the Ordnance Department in World War II was outstanding. His talents for organization were amply displayed in the two Institutes he helped to conduct for one of the Nation's principal industries.

• **COL. JOHN G. BOOTON** (U.S.A., Ret.), Ordnance Officer of the Eastern Defense Command and the First Army during World War II, died on May 19th, at the Chelsea Naval Hospital, Bos-

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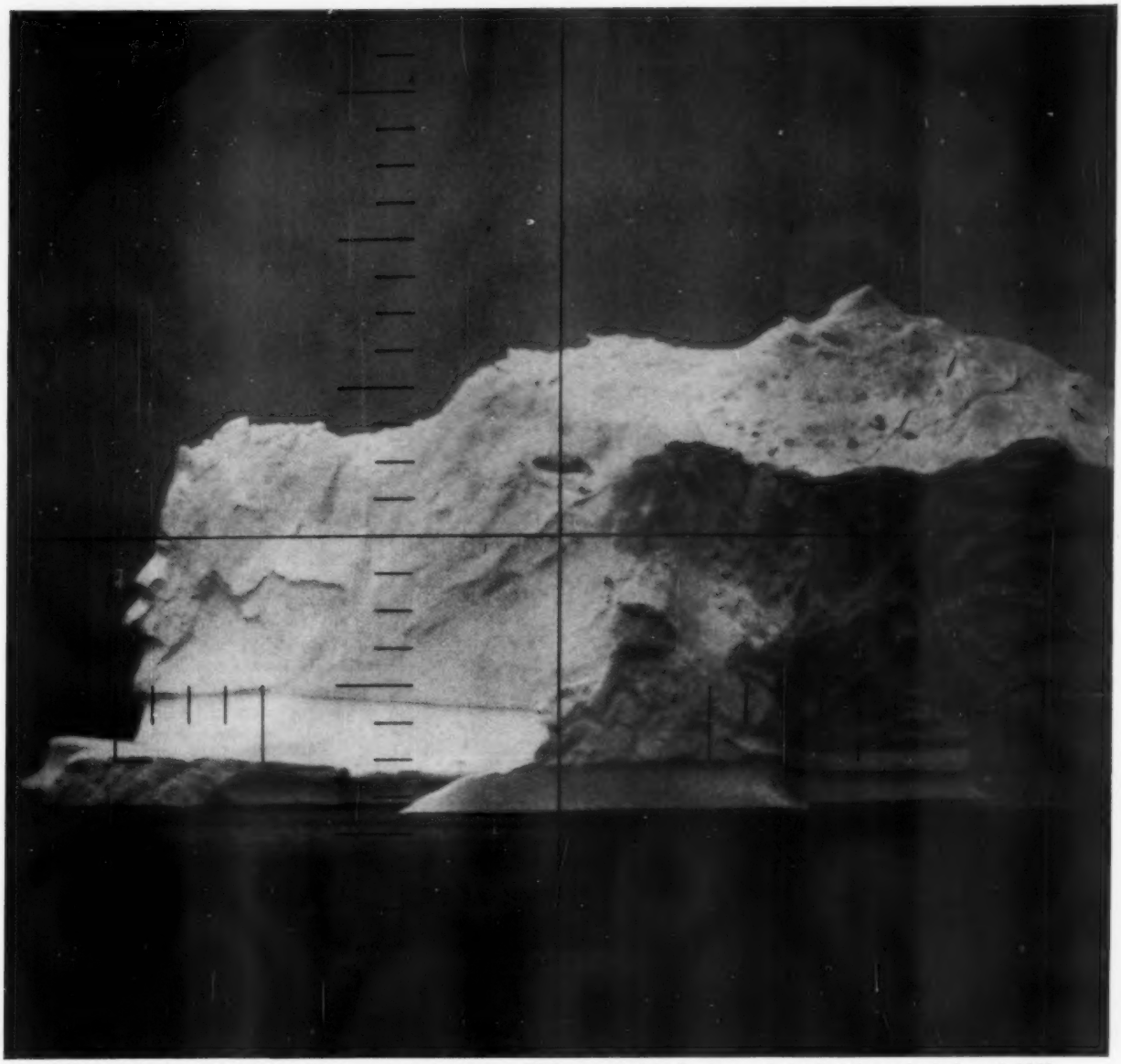

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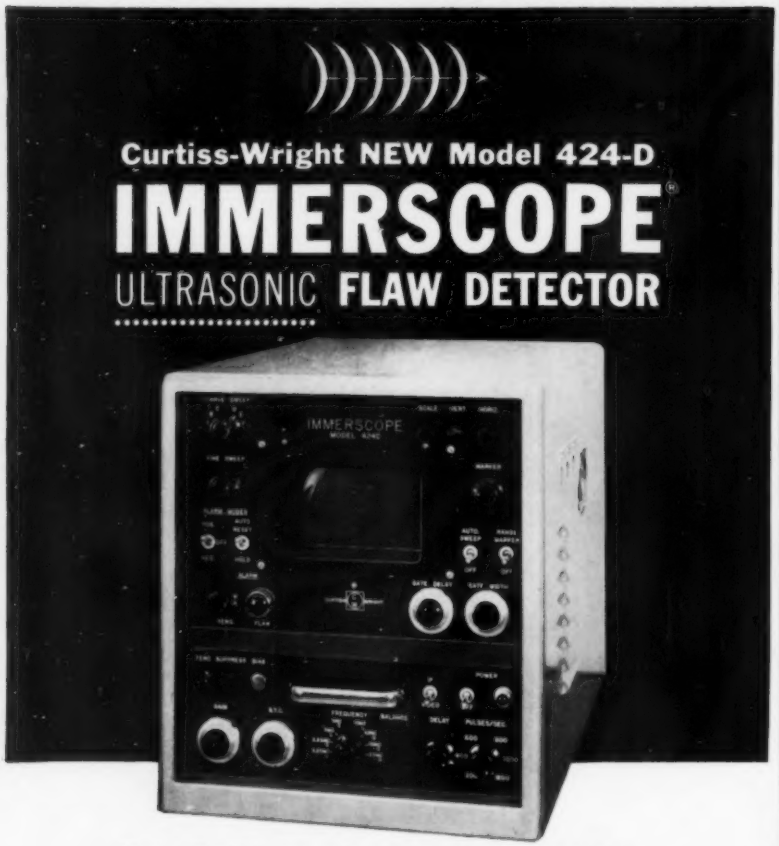

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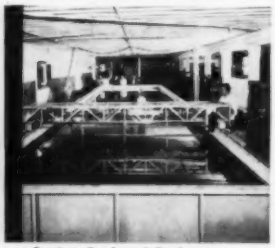

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Necrology

ton, Mass. Services were held at the Old Cadet Chapel, West Point, N. Y., on May 23rd.

Colonel Booton was born in Delong, Ill., and received his early education in Abingdon, Ill. He was graduated from the U. S. Military Academy in 1911 and was an instructor at West Point from 1915 to 1917.

An expert in gunnery, he supervised construction of the Erie Proving Ground during World War I, and from 1919 to 1924 was executive officer to Maj. Gen. C. C. Williams, Chief of Ordnance. He was a member and later Chairman of the Ordnance Claims Board. He later served in the Boston Ordnance District and the Hawaiian Ordnance Depot.

Colonel Booton developed the mechanical time fuze while at Frankford Arsenal, Philadelphia, from 1932 to 1935, after which he was in charge of the Ammunition Division of the Ordnance Technical Staff in Washington. He later commanded the San Antonio Arsenal, Tex.

Following duty at Springfield Armory as chief of research and development, Colonel Booton retired in 1947 after thirty-six years of service.

He then became connected with Hollingsworthy & Whitney in Boston, followed by three years as a consultant at Watertown Arsenal, Watertown, Mass.

He was a former president of the West Point Society of Northern New England and of the New England section of the American Statistical Society, a member of the Harvard Alumni Graduate School of Business Administration, and the Association of Cost Accountants. He was a charter member of the Ordnance Association and will be missed by his many friends in and out of the service.

• **EDGAR B. JESSUP**, a life member of the Ordnance Association, died in San Francisco, Calif., on May 11, 1961. He was a leader for many years in the activities of the San Francisco Post and served on the board of directors and as president of the Post.

Mr. Jessup was president and general manager of Marchant Calculators, Inc., from 1933 until 1957 when he became chairman of the board. He retired from active office in 1958 when Marchant was merged with Smith-Corona, Inc.

He also had been president of Marchant Calculators, Ltd., of Canada and the Marchant Inter-American Company and chairman of Marchant Research, Inc. Before 1933 Mr. Jessup had been with the Monroe Calculating Machine Company and the Underwood Elliott Fisher Co.

He was a director of the Saule Steel Company, the Western Die Casting Company, and the First Western Bank & Trust Company, and was active in civic affairs in his home city of Oakland, Calif.

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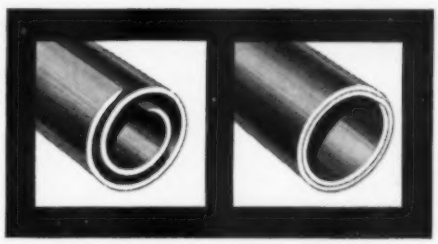

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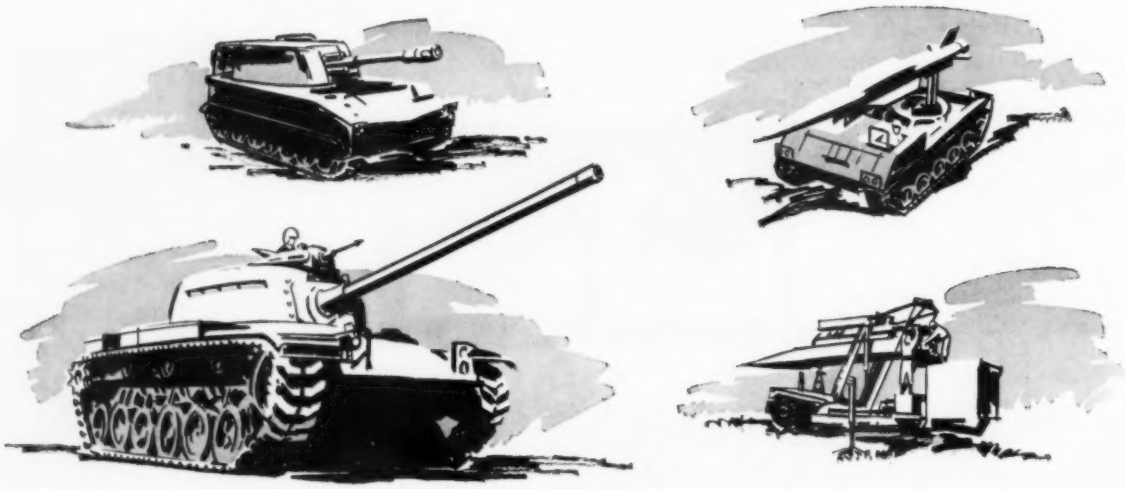
NOW...A STATIC INVERTER TO WITHSTAND PUNISHMENT LIKE THIS ON



TANKS AND HEAVY-DUTY COMBAT VEHICLES

New Hamilton Standard steam-proof inverter designed to meet rugged secondary power requirements in ambients to 150°F... shocks to 50G's

A new solid-state inverter has been developed by Hamilton Standard to meet the full range of combat conditions in tanks and other ordnance vehicles. This unit is the result of a comprehensive development program in which the primary design criteria were exceptional reliability in temperatures as high as 150°F and dependable performance despite shocks to 50G's and constant vibration.

Rated at 18-30 V DC input; 115 +5, −3 V AC output, the inverter operates at 400 cycles ±1% and in ambients from —65°F to +150°F. The unit is silent, fully silicon-transistorized, and utilizes conservatively rated components throughout. It is completely sealed against water, dirt, dust ... and impervious even to steam cleaning. Because the inverter is self-enclosed, internal temperatures may attain 285°F, yet performance is unaffected.

Although designed specifically for tanks, this static inverter suits power requirements for a variety of ordnance vehicles. It is an ideal power supply for gyros, servos, control motors, and power computers in such vehicles as: weapon or personnel carriers, missile launchers, tank destroyers, and gun directors.

An illustrated static power conversion guide is available on request. For your copy, write: Hamilton Standard Electronics Section 120, Broad Brook, Connecticut.

UNITED AIRCRAFT CORPORATION

HAMILTON STANDARD DIVISION

ELECTRONICS

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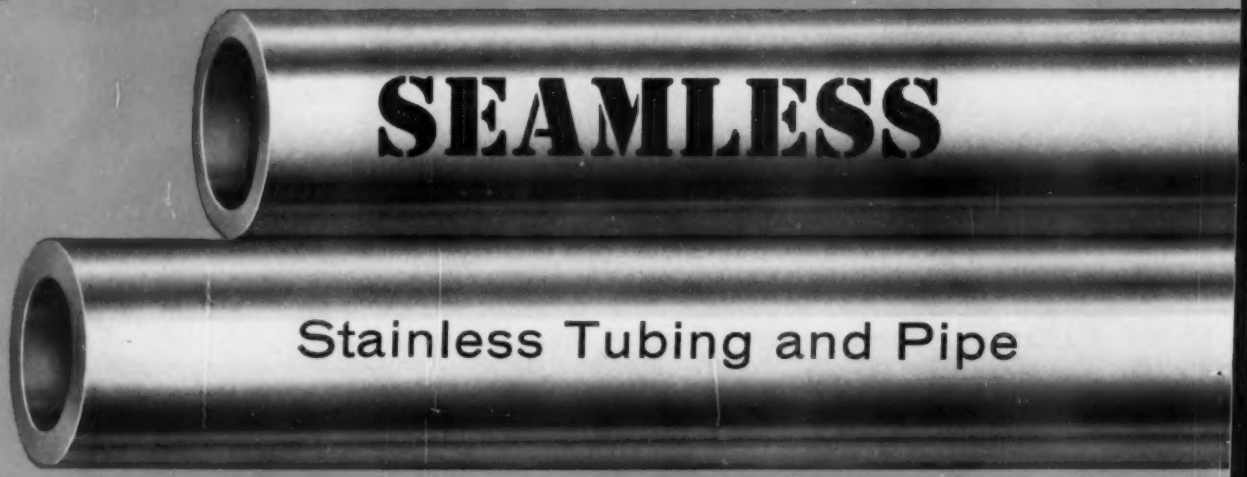

The right answers to a wide variety of corrosion and high temperature problems in heat transfer equipment and process piping systems are provided by SEAMLESS Stainless Tubing and Pipe now made by Carpenter. At every stage of their manufacture, the accent is on quality and uniformity. Both are initially hot formed by the best available extrusion process. Stainless alloys for their production are made in Carpenter's own specialty steel mill to closely balanced analyses. Consistently uniform structure and utmost freedom from impurities throughout these stainless steels are assured by Carpenter's exclusive Mel-Trol® process.

Cold finishing gives all Carpenter SEAMLESS Stainless Tubing and Pipe extremely close accuracy of O.D. and I.D. dimensions, excellent physical properties and super-smooth surfaces. Optimum corrosion resistance, strength and working properties are made certain by careful annealing, pickling and passivating under strict quality control. Rigid final tests and inspections insure that all Carpenter SEAMLESS Stainless Tubing and Pipe always is supplied exactly "as ordered".

Both tubing and pipe are available to ASTM, AMS and Government Specifications in a full range of standard stainless analyses and Carpenter Stainless No. 20Cb. Tubing sizes are ¼" to 6⅝" with wall thicknesses of .004" to .864". Pipe sizes are ⅛" to 6" in Schedules 5, 10, 40, 80, 120, 160 and Double Extra Heavy. Popular types and sizes of both tubing and pipe are available from large stocks in principal U. S. cities.

Get full information on your needs from the nearest Carpenter Representative or Distributor. A new Selecting and Buying Guide, Bulletin 128, is available on request to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

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Carpenter steel

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NEW DEVELOPMENTS

ASW Drone Helicopter

The U. S. Navy has a new, long-range antisubmarine weapon system under development called "DASH" (drone antisubmarine helicopter) which would provide a destroyer with a long-range striking capability heretofore unknown in surface escort antisubmarine warfare. The drone is a compact, coaxial-rotor, weapon-carrying helicopter designated Model DSN-1, developed and produced by Gyrodyne Company of America, Inc.

Modern destroyer sonar gear can pick up a submarine many miles away and deep below the surface, at which point the submarine is not apprehensive of attack. The addition of a drone helicopter will extend a destroyer's attack capabilities virtually to the limit of its sonar range and will enable the destroyers to strike at the submarine with homing torpedoes long before the submarine has begun to expect hostile action.

The DSN is a remotely controlled, unmanned drone which can be flown from the deck of a destroyer in any weather without risk to a pilot's life. With a payload of homing torpedoes, it can fly to the area where sonar gear has detected the presence of a submarine, hover there until instructed to drop its weapons, and then fly back to the parent ship for rearming.

Global Communications

A unique radio research facility, employing a 120-foot-wide saucer-shaped antenna with a surface contour of unprecedented accuracy, is being built for the U. S. Air Force for global communications and space studies.

Scheduled to be "on the air" by the end of 1962, the radio facility is designed to serve as a test bed for development of the large ground-based transmitting and receiving equipment that will be needed to operate high-capacity satellite-relay systems for round-the-world communications.

As an instrument for radio communications research, the system will be used to probe the troposphere and the ionosphere and to study atmospheric irregularities that may limit radio antenna performance (how narrow a beam actually can be produced and how accurately it can be aimed), similar in principle to the limits the atmosphere imposes on astronomical observations with large optical telescopes.

Integrated Navigation

Integrated navigational systems that combine two advanced developments—a position-and-homing indicator (PHI) and a Doppler radar system—will be used to equip NATO military aircraft.

PHI is a self-contained navigation system that, in effect, "computes where it is" and keeps track of all course changes and speeds. It gives the pilot a choice of twelve pushbuttons, each providing on an indicator the heading to fly and distance to go to reach any of twelve preset destinations.

Doppler radar continually bounces radar beams off the earth's surface and compares the returning "echo" to compute actual ground speed, ground position, cross winds, and distance to destination. In the integrated system, Doppler information is fed into the PHI to help it provide heading and distance to any of the twelve preselected destinations.

Lightweight Amphibious Truck

The revolutionary Chrysler-built XM-410—the U. S. Army's lightweight, 8 x 8, floatable 2½-ton cargo truck—recently successfully completed a grueling 10,000-mile reliability run across the western half of the United States. To date, seven models of the XM-410 have been designed and developed by Chrysler for the Ordnance Tank Automotive Command. All have been undergoing suitability testing for nearly a year at various military sites in the United States and Alaska.

New 2½-ton truck can carry 16 soldiers.

Fully loaded with 5,000 pounds of payload, the lightweight vehicle weighs less than the Army's present 2½-ton, 6 x 6 truck empty. It is 2½ feet shorter, air droppable, and can swim water obstacles without advance preparation or kits. Because of its independent suspension and large low-pressure tires for each of its eight driving wheels, it has cross-country ability comparable to a tank, yet is largely built from existing commercial truck components and possesses the greater reliability of wheeled vehicles.

Hunt for the Hunter

A former Navy tanker, the U.S.N.S. Mission Capistrano (TAG-162), has been modified to carry a very high powered sonar transducer to be used in the detection and tracking of submarines in connection with Project Artemis. Artemis is an exploratory development effort sponsored by the Office of Naval Research to determine the feasibility of using the transducer and high-gain receivers, together with advanced data-processing equipment, for locating submarines at very long range in large ocean areas.

The transducer is five stories high and weighs hundreds of tons. The Mission Capistrano, which has a full-load displacement of 17,340 tons, is equipped to raise and lower the sound source in the water and provide power for its operation. The electrical power used in the sound source would furnish lights for a town of 50,000 persons.

A tower called Argus Island has been installed thirty miles southwest of Bermuda as a relay point for hydrophones placed on the ocean floor. The tower has been erected on top of an extinct underwater volcano.

Prime contractor for the Artemis project is Hudson Laboratories of Columbia University. Some thirty university, government, and industrial-scientific groups in the United States are involved in various aspects of the program.

New Voice Radio

A revolutionary development in radio voice communications was revealed recently by the Martin Company's Orlando Division. The new system, called RACEP, is claimed to be one of the most significant developments in the field of voice communication electronics since the end of World War II.

RACEP stands for "random access and correlation for extended performance." The equipment is the equivalent of a private radio telephone system which has all the operating characteristics of an ordinary telephone system without the use of wires or central switchboards. With RACEP, a subscriber can "dial" any other subscriber and talk privately with no interference.

Essentially, RACEP adapts a new modulation technique to carry voices in the form of quick pulses of radio energy on a single frequency band simultaneously among many persons and locations. It achieves its extraordinary performance by putting to use the pauses and breaks in normal conversation as well as the idle time between calls.

This is accomplished by disintegrating

and coding speech signals into millionth-of-a-second fragments, combining them at random, and transmitting them all at once over the same channel. Only receivers preset for the proper code of a specific conversation can receive it and reconstruct its fragments into a normal flow of speech. The coded circuits of transmitters can be varied manually to match those of particular receivers.

Because of the random-access feature of RACEP, there is no central communications center that can fail and thus paralyze total communications. Each RACEP unit is self-contained and can reach any other unit from any location merely by setting its transmitter to the receiving code of the other unit.

Callers do not have to wait until the channel is clear before making a call. Scores of callers on the same frequency can use that band at the same time due to the random-access technique. In addition, a command override feature permits all receivers within range to accept an emergency call from a single transmitter originating the call, regardless of whether the individual receivers are in use at the time the command override is employed.

Breakproof Coder

An optical device that makes codes and secret messages "breakproof" was disclosed recently. Nicknamed the "Scrambler," the unit it made up of more than 300,000 tiny glass fibers, carefully arranged in approximately one square inch of space. After lining up the fibers, technicians bend and rearrange them into secret patterns.

When the Scrambler coding device is placed over a message the result is a maze of dots without any visible pattern. Only the sender and receiver have the key fiber optic decoding device, so the message cannot be broken.

Project Iceway

A 14,000-foot runway of natural ice and several 200-foot and 500-foot circular parking pads of ice in North Star Bay, Greenland, have been constructed by the U. S. Air Force as part of a research program in ice engineering entitled "Project Iceway." This is the first time that heavy jets and Century-series fighters have been used to test ice platforms.

The effect of such traffic is being determined by measurements of ice deformation, its strength, density, elasticity, creep, and grain structure under actual operating conditions.

The runway, near Thule Air Base, was constructed of natural ice. The parking pads, located on the shoreline end of the runway, were built by flooding. One pad was constructed of natural sea water; the others incorporate strands of fiberglass—a reenforcement technique developed by the Geophysics Research Directorate.

Successful Rocket Belt

For the first time man has used a rocket—carried on his back—to achieve controlled free flight over the ground, according to Bell Aerosystems Company which has built and flown an experimental rocket belt for the U. S. Army Transportation Research Command.

H. M. Graham hovers with Bell rocket belt.

Bell test engineer Harold M. Graham has flown the small rocket lift device (SRLD) over the ground at distances up to 360 feet. Average altitude for distance tests has been from three to four feet but Graham also has flown to the top of 30-foot-high hills using the rocket belt. No attempts have been made to achieve maximum speed with the rocket belt, but the average speed on a test run was estimated at 20 miles an hour.

Although the current device is a feasibility model designed to prove that lightweight rocket power can lift a man and transport him over the ground in controlled flight both the company and the Army have studied applications for operational units that may be developed under the SRLD program. The most frequently mentioned military use of man-rockets would be to transport foot soldiers over surface obstacles such as streams, rivers, ravines, barbed wire, and mine fields. Rocket belts may be employed during amphibious operations, permitting assault troops to fly from ship to shore. Rocket belts also could be used to reach the top of vertical obstacles such as cliffs and steep hills.

Basically, the Bell man-rocket consists of a twin-jet hydrogen-peroxide propulsion system mounted on a fiberglass corset which has been molded to fit the back and hips of the operator.

Metal control tubes extend forward on each side of the operator. A control stick on one tube permits the operator to change his flight direction. A motorcycle-type hand throttle mounted on the other tube allows him to regulate rocket thrust levels, thus controlling his rate of climb and descent. The device has proved so stable in flight that pitch and roll are easily controlled by movements of the operator's body.

The SRLD rocket propulsion system is fully throttleable. When activated by the pilot's controls, hydrogen peroxide is forced under pressure into a gas generator where it contacts a catalyst and decomposes into steam. The steam escapes through two rocket nozzles providing thrust.

New Antitank Weapon

The Army will purchase the French-developed Entac guided-missile system for use against enemy tanks. The Entac is small, light, and suitable for use by the infantry. The missile is directed to the target by an operator who maneuvers a stick to give the appropriate correction commands transmitted through fine wires played out from the missile as it flies to the target.

The missile and its launcher weigh thirty-seven pounds; the missile in flight weighs twenty-seven pounds. It carries a shaped-charge warhead designed for maximum effectiveness against armor, and utilizes a solid-propellant rocket motor. As Entac equipment becomes available, the presently used SS-10 will be phased out.

Ground Effect Machines

Avro Aircraft Limited and the Ingersoll Kalamazoo Division of Borg-Warner Corporation have signed a joint venture agreement to participate mutually in future ground-effect machine programs. A ground-effect machine (GEM) is a vehicle which travels a few inches above the ground on a cushion of air emitted from jet nozzles in the underside of the vehicle.

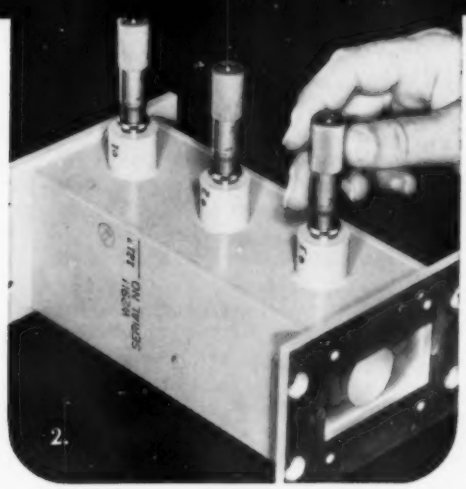
The two firms recently completed preparation of a proposal to the Office of Naval Research for an amphibious GEM which would be used to bring troops and cargo from ships offshore through the surf and onto the beaches.

Antisubmarine Helicopter

Tests of the new antisubmarine HSS-2 helicopter have proved satisfactory to the Navy. Helicopters, like the longer-range S-2-F antisubmarine search planes, are based on carriers which move with other vessels under protection of aircraft.

Major factors which make the HSS-2 better than its predecessors are greater speed and reliability for underwater searches; much more efficiency in performing a continuous search of the area just ahead of its fleet; and less sound and vibration with the new motors, thereby benefiting both personnel and the delicate instruments whose efficiency is a first need in detection of enemy subs. The new craft

1.



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3.

TI's RADAR CAPABILITY...

4.

5.

6.

For systems requirements, Texas Instruments now offers major advancements in microwave techniques resulting from 15 years' experience in the development and production of radar equipment. Significant technological advancements include receiver front-end improvement through the following...

1. Broadband parametric amplifiers — typical improvement in radar system noise figures possible with these devices ranges from 4 to 6 db. For comparable range improvement, using conventional techniques, it would be necessary to double antenna size or quadruple transmitter power.

2. Pre-selector filters—screen out interference from other radars.

3. Solid-state microwave sources — used as local oscillators or parametric amplifier pump sources... these devices are crystal-controlled for high stability and can be used in any application requiring a stable, reliable signal source.

Examples of TI radar systems operational today include the following...

4. Surveillance sensors for the U. S. Army Signal Corps AN/USD-5 combat drone, produced by Fairchild.

5. AN/APQ-86 reconnaissance radar in the U. S. Army Signal Corps L-23 aircraft.

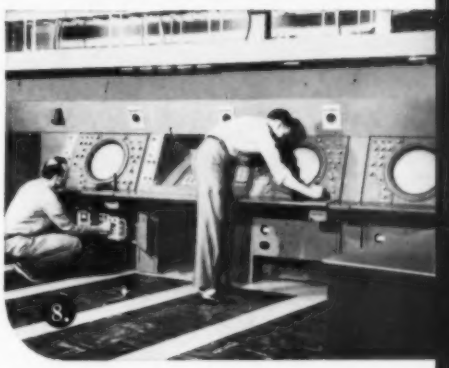
6. AN/APS-80 radar and APA-125A indicator in U. S. Navy P3V ASW patrol aircraft.

7. Engagement displays for Nike-Zeus — the U. S. Army's anti-ICBM defense system, produced by Western Electric Company.

8. ASR-4 radar for Federal Aviation Agency controls airport traffic in congested areas. Display console gives clear indication of moving targets.

9. ASR-4 equipment cabinets typify system's design — all components uncover for easy servicing.

7.



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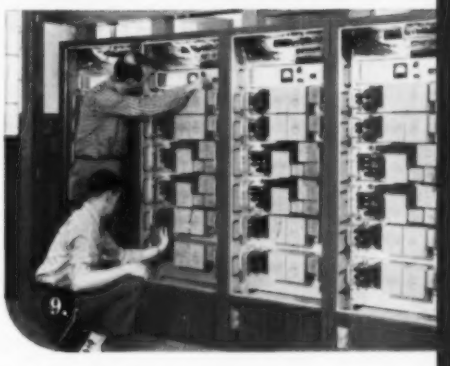

9.

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P. O. BOX 6015 DALLAS 22, TEXAS

17809

also has more stability which permits take-off in winds of 48 knots and good handling on deck, even in extreme crosscurrents, as well as making a normal landing on one or two engines.

The HSS-2 also has automatic blade-folding ability (practicable in 45-knot winds) which reduces deck-movement time by one-half, thereby averting damage to the helicopter in gales. It likewise permits more compact stowing, which is the equivalent of employing more helicopters than now is possible.

The HSS-2 recently set a world helicopter speed record of 192.9 miles an hour, bettering the previous Russian record of 166.5 m.p.h.

New Army Engine

The Army Ordnance Tank-Automotive Command will receive four pilot models of a new Army engine for testing in tactical vehicles under Arctic and desert conditions. Developed by the Caterpillar Tractor Company, Peoria, Ill., the engine is a turbocharged, 5-cylinder, compression-ignition model about the same size and weight as a 220-horsepower engine but produces almost twice the power.

The liquid-cooled, 4-cycle, in-line engine is rated at 425 brake horsepower at 2,400 r.p.m. without fan or generator. Compact, it measures less than 36 inches wide, 42 inches high, and 46 inches long, and weighs 1,950 pounds.

It is part of a family of engines being developed by Caterpillar with 5.4-inch bore and 6.5-inch stroke. Development of these types of engines with common bore and stroke allows maximum interchangeability of parts.

Radars for Mauler

Radars to fire the U. S. Army's Mauler missile accurately, even while its carrier is weaving through battle areas, are now under development. Mauler is a new U. S. Army air-defense missile system designed to destroy short-range tactical missiles as well as high-performance aircraft that bomb, strafe, harass, or reconnoiter battle-area positions. Its unique ability to fire on the run makes it ideal for use by fast-moving field forces.

The Army Rocket and Guided Missile Agency, an element of the Army Ordnance Missile Command, Redstone Arsenal, Ala., has over-all charge of Mauler development.

New Navy Aircraft

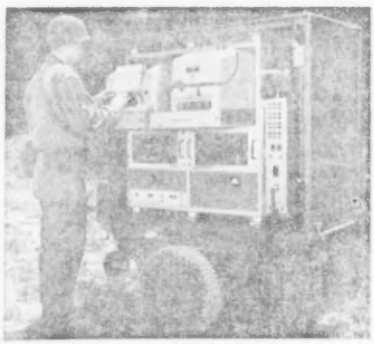
The Navy recently accepted its first P3V-1 Orion aircraft at the Lockheed plant, Burbank, Calif. The new craft features the most effective electronic, sonic, and magnetic equipment ever developed for this purpose.

It is designed to perform several important tasks: offshore surveillance, contact investigation, task-force protection, and submarine detection and destruction.

Although it has a cruising speed of more than 400 m.p.h., once over target areas, the Orion can fly with perfect control at speeds of less than 175 m.p.h. It carries a crew of ten in its fully pressurized, air-conditioned cabin. A land-based aircraft, it is powered by four Allison turbine engines. It has a 99-foot wingspan and an over-all length of 116 feet, 10 inches.

Mobile Communications Units

Three new long-range, high-powered, emergency communications systems designed for mobile use in isolated areas have been delivered to the Army Signal Corps by Adler Electronics, Inc. The



A station of the AN/TSC-20 system.

three systems, which can be moved by existing aircraft, have ranges of 2,500, 5,000, and 7,000 miles, respectively. Any one of the systems can be installed in less than four hours as opposed to the months required for the installation of fixed stations with the same power.

Immediate voice or teletype messages can be transmitted over the systems on a worldwide basis, making them particularly valuable for the Strategic Army Corps. The systems are capable of by-passing fixed Army communications system stations, which may be inoperative, and communicating directly with the Pentagon. They also can tie in with bases placed in isolated areas or areas where normal communications have been disrupted, such as occurred in the Chilean earthquake.

A unit designated as the AN/TSC-18 is considered the world's most powerful transportable communications equipment. Its 7,000-mile range provides simultaneous transmission and reception on three telephone and sixteen teletype channels. These units can be airlifted in three C-124 aircraft.

The second system, the AN/TSC-19, can operate on 3 telephone and 16 teletype channels for a distance of 5,000 miles. It can be carried in two C-124 aircraft.

The third system, the AN/TSC-20, can be airlifted by C-119 aircraft or by helicopter. It has one voice and four teletype channels and can operate up to 2,500 miles.

Packaged Antennas

Antennas that can be packed into containers about the size of a box camera and then expanded on command to full-sized arrays are being investigated for the Air Force Systems Command (AFSC).

These antennas, which can be erected by mechanical or pressure techniques after the carrier vehicle obtains orbit, are potentially useful for satellite-to-satellite communications and weather mapping.

Experimental models designed by the Lockheed Missile and Space Division, Sunnyvale, Calif., and the Schjeldahl Company, Northfield, Minn., have been delivered to AFSC's Aeronautical Systems Division, Dayton, Ohio.

Pressure erection techniques have tremendous potential, scientists claim, because of light weight and volume expansions as high as 100 to 1. An antenna folded into a one-cubic-foot box can be unfurled into a sphere six feet in diameter, and remain erected as long as twelve months.

A variety of structures, ranging from complicated frames of straight elements to large curved surfaces, can be constructed with pressure-erection techniques. Strong, flexible materials are required because the structure must maintain its own rigidity after erection. Materials must be able to withstand environmental effects, such as micrometeorite bombardment, absence of air pressure, solar and nuclear radiation, and extreme temperature variations.

Largest of the pressure-erected models is the sphere, which is the most stable shape that can be maintained in space. Antennas can easily be formed by metallic coatings of appropriate portions of the spherical surfaces. It is erected by the sublimation of chemicals when the satellite is in orbit. It can be folded into a package approximately thirty inches long and eight inches in diameter and can be expanded into a sphere seven feet in diameter.

Speedy Runway Survey

Air Force scientists are saving time and money with new equipment designed to determine how "bumpy" runways are at various bases in the United States. The results will provide data for designing landing gears, fuselages, wing spars, and nacelle supports for advanced aircraft such as the new C-141 jet transport and other supersonic aircraft.

In the past, surveys of a selected facility usually took six months to complete. With the new technique, the job can be completed in five days. An additional saving results from the speed with which the final data can be analyzed. Only two to four hours are now required in comparison with the six to eight months spent using old methods. (*Contd. on p. 102*)

The pilot is inside, flying over enemy lines.

The SD-1 Surveillance Drone flies remotely controlled tactical surveillance missions without risking manned aircraft or pilot. It is extremely mobile, simple to use and maintain, and can be readily adapted to carry TV or film cameras, infrared, radiation detection or radar reconnaissance equipment. The SD-1 is the Army's only operational surveillance drone. Northrop's Radioplane Division developed and produces it.

RADIOPLANE
A DIVISION OF
NORTHROP

Measurements are taken with two electronic photoelectric cell-computer carts or trailers. One houses a photoelectric cell which transmits a light beam horizontally across the runway surface.

Photoelectric cells in the second cart are electronically geared constantly to pick up the light beam from the first cart. On the second cart a small wheel rides along the runway surface. Linked electronically to the photoelectric cells, the second cart automatically records the runway "pattern" or profile with a computerlike data storage unit. Stored on paper tape, this information provides a permanent record for later evaluation.

New Light Helicopter

The Bell Helicopter Company of Fort Worth, Tex., and Hiller Aircraft Corporation of Palo Alto, Calif., won the Army light observation helicopter design competition. The Bell D-250 design and the Hiller Model 1100 were considered most suitable for meeting modern Army reconnaissance and mobility requirements and eventually for replacing three other Army aircraft now in use.

The new helicopter will be a lightweight, single-rotor, 4-place craft powered by a T-63 gas turbine engine and will be capable of carrying a 400-pound payload in addition to the pilot and fuel. With a speed of 110 knots, it will be as fast as the L-19 airplane and faster than the current H-13 and H-23 helicopters.

Helicopter Simulator

The Navy recently accepted delivery of its first helicopter flight and weapons system simulator—a training device that duplicates the full performance range of the all-weather HSS-2 Sikorsky helicopter. The HSS-2 is equipped with the AN/AQS-10 sonar and is designed as an advanced system for antisubmarine warfare.

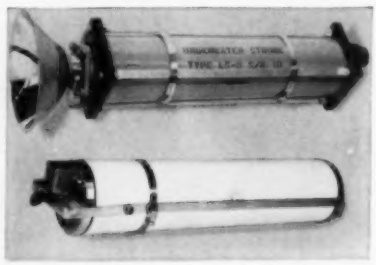
The helicopter weapons system trainer, the first ever to be produced, was designed and built by Melpar, Inc., Falls Church, Va., under contract to the U. S. Naval Training Device Center, an activity of the Office of Naval Research.

The simulator will be used to train crews for all phases of tactical missions, including communications, navigation, ASW search procedures, target tracking, detection and classification, and delivery of weapons. The flight-control equipment, cockpit, and sonar compartment in the trainer duplicate exactly the actual helicopter. The forces felt by pilot trainee on his control stick and rudder pedals during operation are the same as those in the aircraft. The trainer simulates the behavior of a total of twenty of the helicopter's systems including oil and fuel, hydraulic, blade-folding, landing-gear, and armament.

The instructor can present the student with problems involving as many as five underwater targets. The speed, rate of turn, heading, location, and depth of these targets can be suitably controlled. Oceanographic conditions such as sea state noise, bottom effects, and detection range can be programmed by the instructor. The aural and visual displays from the sonar transducer, which is lowered into the ocean, also are simulated.

New Oceanographic Camera

An oceanographic camera and synchronized electronic flash system have been developed by Edgerton, Germeshausen & Grier, Inc., Boston, Mass., for use with the



Underwater flash unit, top, and camera, bottom, can operate under great pressure.

bathyscaph TRIESTE. Designed for attachment to the outside of the TRIESTE's hull, the camera and flash units are able to withstand pressure of more than 8 tons per square inch at the ultimate ocean depths of 37,500 feet. The system also is designed to withstand the near-freezing temperatures prevalent at extreme ocean depths.

The camera unit contains two 35-mm. cameras, each capable of taking 500 pictures at a loading. Depth and time are automatically recorded with every exposure. Controls mounted inside the bathyscaph enable the scientist crew to take only pictures which are of particular interest.

Basic principles of the system were originally developed by Prof. Harold E. Edgerton of the Massachusetts Institute of Technology, who supervised design and construction of the present system.

Research Ice Station

Arlis-2, a drifting ice island used as a scientific research station, has been established by the Arctic Research Laboratory in the Arctic Ocean about 130 statute miles north of Point Barrow, Alaska. Arlis-2 (Arctic Research Laboratory Ice Station No. Two) is the second station established by the Laboratory, an Office of Naval Research facility operated by the University of Alaska under a contract arrangement.

Arlis-2 measures 2 by 3¼ miles. Its thickness has not yet been determined, although it is estimated to be more than fifty feet. Ice islands are composed of fresh-water ice and are many times thicker than the floe ice of the Arctic pack. The latter is commonly six to eight feet thick and is rarely as thick as twelve feet.

Clean Room for Bearings

Cleanliness is a relative term, but at the Fafnir Bearing Company it involves a "clean-room" system which is divided into several areas separating each of the concluding stages of miniature ball bearing production.

The final assembly, inspection, and packaging of bearings for precision instruments and other mechanisms require conditions free from airborne dust and dirt to an extraordinary degree. For added assurance, the bearings are subjected to a series of cleaning processes, tests, and other protective measures which guard against any possibility of contamination up to and including the time they are packed in sealed vials or bags.

The air in all of the areas is passed through five filters, including two precipitrons and one of the Cambridge absolute type, excluding contaminants over 0.2-micron or 0.000008-inch particle size. Temperature is controlled at 75 degrees, plus or minus 1 degree, and humidity is maintained between 30 and 45 per cent. Both are monitored by a master control board located in the foreman's office. Entrance of airborne dust is prevented by outward pressurization of the air, increasing by degrees in proportion to the criticalness of each area.

Deep Dives Possible

A Swiss diver interested in the physiological problems associated with deep-sea diving has successfully tested a gas formula which reduces by a number of hours the time required for divers to surface after deep-sea operations.

Hannes Keller, a former mathematics instructor from Winterthur, Switzerland, recently made a demonstration dive to a simulated depth of 700 feet, performed a heavy physical labor test at that depth, and surfaced in about 2.5 hours, using the formulas and techniques he has developed. Under present methods, such dives normally require decompression periods several times longer. The Navy is planning a more detailed examination of Mr. Keller's discovery.

In developing his formula, Mr. Keller worked closely with Dr. Albert Buehlmann, a noted physician specializing in respiratory and circulatory medicine at the University of Zurich. The basis of Mr. Keller's discovery is a mathematical formulation for the use of new breathing gas mixtures and new techniques in the use of these gases, along with a new series of decompression tables. Modifications in the proportions of the gases used are made at various points in the diver's ascent. Details have not been made public.

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SPACE ARMAMENT

High-Thrust Vehicles

NASA has awarded three contracts for comprehensive studies of possible future space vehicles beyond the Saturn class—rockets having first-stage thrust of 6 to 12 million pounds. Representative and promising hypothetical vehicle configurations are being studied. Some of the vehicles combine solid and liquid chemical fuels and others liquid chemical and nuclear propulsion.

Among the study considerations are: (1) Optimum use of nuclear propulsion in large rockets; (2) desirability of attempting to recover and reuse large space vehicles; (3) attractiveness of a large, high-energy, liquid-hydrogen/liquid-oxygen first-stage booster; (4) solid and liquid fuel in first-stage booster; (5) conventional tandem staging versus the prospect of parallel staging; and (6) pressure-fed versus pump-fed systems.

Man-in-Space Program

The successful suborbital space flight of Comdr. Alan B. Shepard, Jr., from Cape Canaveral on May 10th has focused renewed attention on Project Mercury—the program of the National Aeronautics and Space Administration for putting a manned spacecraft into a controlled orbit around the earth, successfully recovering the vehicle, and investigating man's capacity to withstand the environment of space.

A modified Atlas D booster will launch the manned capsule into a nearly circular orbit which will be established at an altitude of roughly 100 to 150 statute miles. Descent from orbit will be initiated by the application of retrothrust rockets incorporated in the capsule system. After the vehicle has been slowed down by aerodynamic drag, parachutes incorporated in the capsule system will decrease the descent speed even further. Recovery on either land or water will be possible.

The space capsule measures more than six feet in diameter at the base, stands nine feet tall, and weighs over a ton. The capsule is statically stable over the Mach number range corresponding to flight within the atmosphere and is designed to withstand the various combinations of acceleration, heat loads, and aerodynamic forces that will occur during boost and reentry. It has an extremely blunt leading face covered with a heat shield.

A closed-loop control system, consisting of attitude sensors, electronic stabilization devices, and reaction controls, is incorporated in the capsule. The reaction controls maintain the vehicle in a specified orbital attitude and establish the proper angle for retrofiring, reentry, or an abort maneuver through hydrogen-peroxide thrust chambers.

The pilot has the option of manual or automatic control during orbital flight. During manual control, optical displays will permit the pilot to see portions of the earth and sky and will enable him to position the capsule to the desired orbital attitude.

The retrograde rocket system will supply sufficient impulse to permit atmospheric entry in less than one-quarter of an orbital revolution. These rockets are fired upon a signal, either initiated by a command link from ground control, by the astronaut himself, or by an automatic device within the capsule. The impact area can be predetermined because of this control over the capsule's point of reentry into the atmosphere.

The three rocket engines of the Atlas will boost the manned capsule from the launching pad with a thrust of over 360,000 pounds.

After the two booster engines are shut down and jettisoned, the escape tower will be released and the Atlas sustainer engine will accelerate the capsule to an orbiting speed of about 18,000 m.p.h. After reaching the required orbital velocity, the capsule will be released from the Atlas and will follow its selected path around the earth.

The capsule will orbit with the blunt end forward, and at the proper moment in the orbit path the retrograde rockets will be fired to decrease the speed of the capsule so that the reentry sequence can begin. At the proper moment, the main parachute will be deployed automatically to allow the capsule and its crewman to settle gently to earth.

Projects Publicized

Small business firms will have a greater opportunity to share in National Aeronautics and Space Administration proposed research and development contracts through the listing for the first time of the proposals in a publication issued daily by the U.S. Department of Commerce.

Proposed unclassified NASA research and development contracts leading to prime contract awards of $100,000 or more are being published in the Commerce Department's "Synopsis of U.S. Government Proposed Procurement, Sales, and Contract Awards."

The synopsis will include a summary of the request for proposals together with the names and addresses of the firms which have been invited by NASA to submit proposals. This will permit firms interested particularly in subcontracting opportunities in current research and development programs to contact the potential prime contractors directly during the early stages of procurement.

In addition, the NASA Office of Public Information in Washington and all NASA field installations will make available the names of firms attending preproposal briefings and, after the closing date, those which submit proposals. When selected, the name of the successful company also will be made available and published in the synopsis.

New Propulsion Method

A new radio-frequency technique that may be used to propel space vehicles on long interplanetary voyages was announced recently by scientists of the Radio Corporation of America. The new technique employs ultrahigh radio frequencies to accelerate charged particles —electrons and ions—to high velocity. With further development, the process is expected to create enough thrust for spacecraft propulsion in the gravity-free environment of outer space.

The basic "fuel" is plasma—a mixture of ions and electrons generated by successive electrical discharges from a pool of mercury and released into a cylindrical chamber. Radio-frequency power is applied to the chamber, producing an electrical field that is strongest near the plasma source and decreases rapidly with increasing distance along the chamber.

The charged particles in the plasma are accelerated swiftly from the stronger toward the weaker field by electrical interaction—somewhat in the manner of balls gathering speed as they roll down a steep grade. The result is a thrust that acts on the chamber and can be used to propel an object in space.

The thrust can be increased by using higher radio frequencies to accelerate a denser plasma. Successful experiments have been performed at frequencies of 140 and 330 megacycles, and further experiments are planned at a frequency of 2,500 megacycles.

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...yet this rough terrain crane is built *strong* to take the stress and strain of heavy lifts, long hours, tough working conditions. It can travel through mud, sand, other slippery spots that would stop ordinary units. Its weight: only 25 tons!

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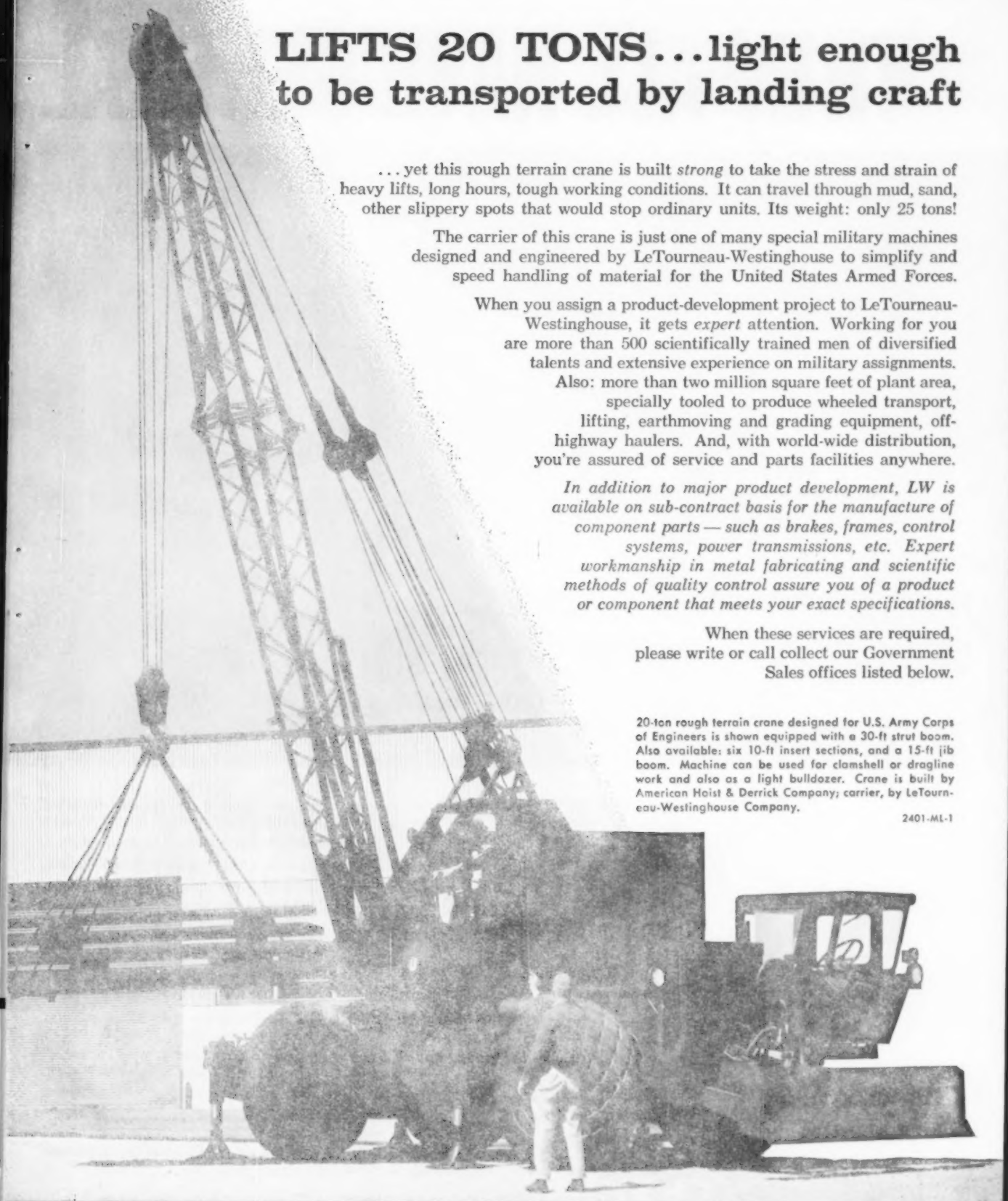

20-ton rough terrain crane designed for U.S. Army Corps of Engineers is shown equipped with a 30-ft strut boom. Also available: six 10-ft insert sections, and a 15-ft jib boom. Machine can be used for clamshell or dragline work and also as a light bulldozer. Crane is built by American Hoist & Derrick Company; carrier, by LeTourneau-Westinghouse Company.

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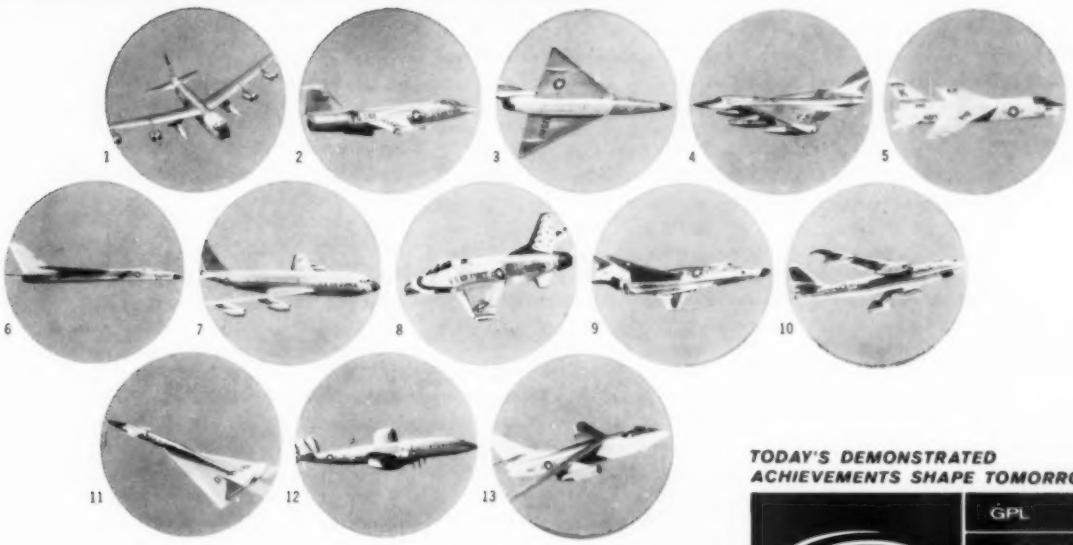

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UNDERWATER ORDNANCE

P. Eleson

Project Mohole.—Congratulations, first of all, to the men and companies of Project Mohole for a startling demonstration of how sound planning and good practical engineering can pay off. The problems of ocean-surface, underwater, and subterranean engineering involved in drilling holes in the ocean floor from the surface in 12,250 feet of water have been surmounted in minimum time and with a minimum of fuss, money, and mishaps.

Cuss-I is back at her home port of Santa Barbara, Calif., and, stripped of her special deep-water positioning equipment, is preparing to return to her regular business of drilling oil wells while anchored in much shallower depths. While off Guadalupe Island, Cuss-I drilled four holes, the deepest of which was 601 feet in over two miles of water. Important to the success of this trial run was the ship-positioning system developed by Robert Taggart, Inc., Falls Church, Va., whereby one man—with the aid of anchored underwater buoys, four Murray & Tragurtha 2,000-horsepower outboard engines, and a central control console—held the unanchored Cuss-I within the narrow position limits required during drilling operations.

This same system will be further improved and installed on the special ship to be built for actual penetration of the Moho—the seismic discontinuity that marks the start of the earth's mantle.

The Navy is watching Project Mohole with more than passing interest in the belief that the secrets it unfolds as to the characteristics of the ocean floor will make a major contribution to its anti-submarine-warfare capabilities.

President Kennedy's new defense posture is boosting spending on the Polaris fleet ballistic missile system by more than a third. Because of borrowing back and forth and adding to the two budgets, it's difficult to break out clear figures for each of the two fiscal years, 1961 and 1962. By lumping the two together, one finds that President Eisenhower's plans called for new obligational authority totaling $2.9 billion, while the new Administration's plans call for $4.1 billion for the same period. This is a major step toward the proposed 45-boat force, since it includes funding for Polaris submarines through Number 19 in fiscal 1961 and funding for Numbers 20 through 29 in fiscal 1962.

Aside from submarines and all their associated equipment, additional funding also will go for missiles, support equipment, crew training, and further research and development (namely on a 2,500-nautical-mile A-3 version of the missile). Contrary to what you may hear, a 1,500-mile A-2 is not going to be by-passed, but should become operational in 1962.

A revolution in underwater navigation techniques and accuracy will come from a requirement that Polaris submarines know precisely where they are at missile-launch time. Publicly admitted FBM submarine navigation aids include: SINS, the submarine inertial navigation system; a celestial periscope for taking star shots while running at periscope depth; a radio "sextant" for taking solar and lunar (and, when it's operational, Transit satellite) shots in overcast conditions; as well as, of course, the old stand-by, dead reckoning.

However, in recent congressional hearings three other navigational aids have been mentioned. These are dependent on measurement of strength, inclination, and deviation of magnetic fields; measurement of gravitational field strength; and accurate "contouring" of the ocean floor. Demands upon technology include extensive and time-consuming mapping of these parameters and development of ultra-sensitive measuring devices.

Bottom piloting probably poses the greatest instrumentation challenge, since careful plotting of the ocean-floor terrain (by direct sounding and possibly Doppler) is dependent on sonar techniques—which, in turn, are subject to the vagaries of ocean temperatures, salinity, and density. Importantly, precision of measurement is required to an unprecedented degree.

Bats with transinterfacial sonar? Recent *in situ* observations by M.I.T.'s Lincoln Laboratory studying the Noctilio bat in Panama and Trinidad indicate this creature effectively transmits sound signals from air into water and receives reflections back through the interface with an accuracy that makes him quite an effective in-flight fisherman.

Navy may stay in the satellite business yet. Despite Defense Secretary McNamara's edict to the contrary, Navy may develop a satellite requirement that the Air Force just doesn't wish to fool with. Naval Research Laboratory's Lofti (low-frequency transionospheric) satellite appears to have found a right big window in the ionosphere for VLF (very low frequency) radio waves. The significance of this to underwater communications is obvious when you realize that VLF radio waves can penetrate the ocean's surface to a depth of several hundred feet.

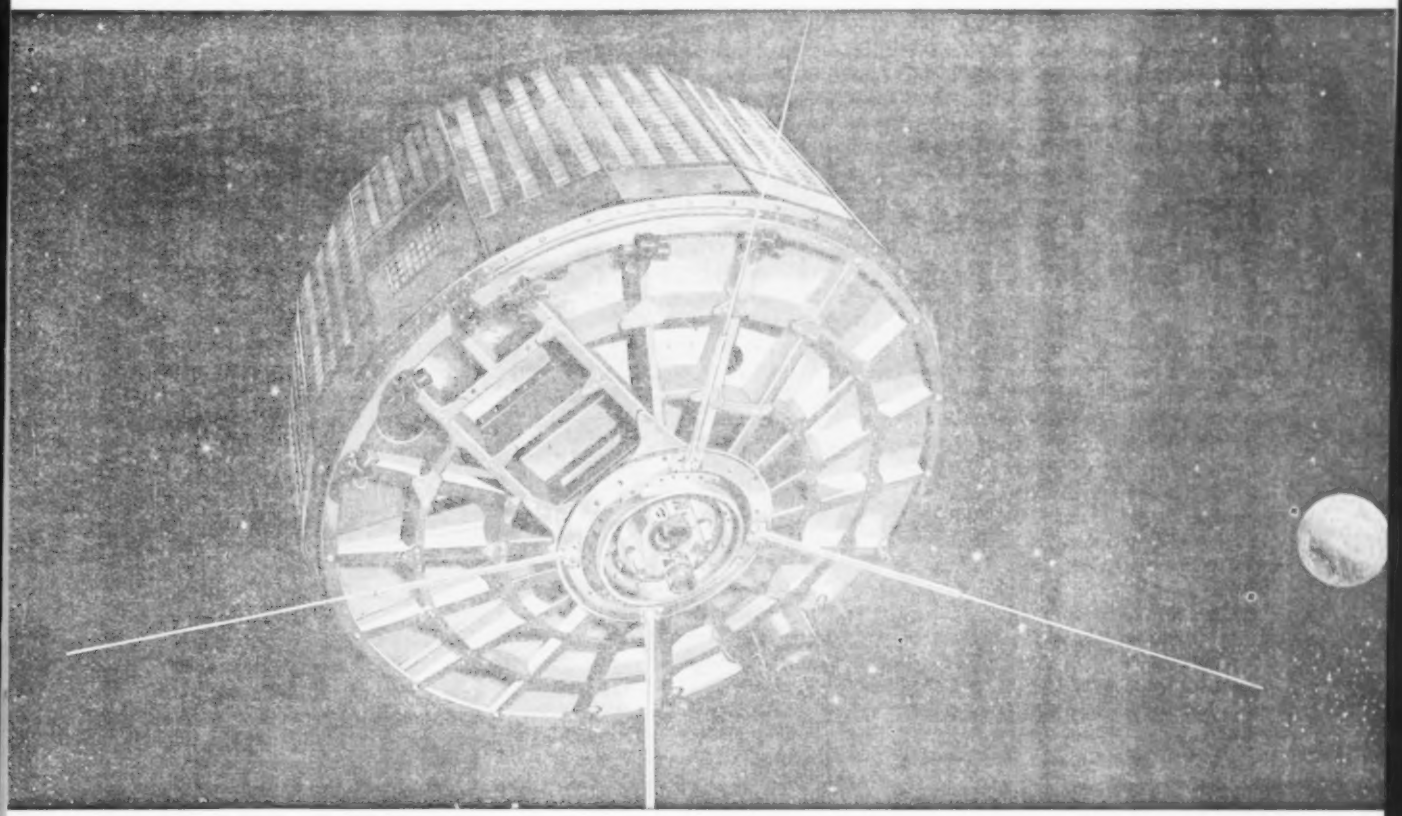
Presently under construction is a system of three extremely powerful VLF transmitting stations at widely scattered locations on the earth's surface. Though both expensive and powerful, these stations could not hope to have the signal strength (therefore penetrability) at the ocean-air interface of powerful relay satellites transmitting from less than 200 miles more or less directly overhead. In the same manner, it might provide the submerged submarine with a means of talking back—which it doesn't have now.

New submarine escape device, the Steinke hood, has been developed to serve much the same purpose as the Momsen lung. In tests, the device—which includes clear plastic hood, snorkel, and air pressure relief valves—enabled a man to "escape" from a depth of 318 feet in 55 seconds of transit time.

Experimental midget submarine X-1 has come out of mothballs to give naval researchers a fish's-eye view of underwater phenomena during special experiments. This is part of an NRL program being carried out in Chesapeake Bay which requires simultaneous observation of the submarine from both above and below the water's surface. For looking down on the craft, a 50-foot enclosed platform has been hooked to the underside of the Chesapeake Bay Bridge. X-1 is a hydrogen-peroxide-powered craft which has had a habit of blowing up. (*Contd. on p. 110*)

Mr. Eleson has been a student in physics and has long held an interest in oceanography. He is an experienced author on technical subjects both here and abroad and is at present professionally interested in the field of underwater ordnance.

"WEATHER EYE" IN SPACE



RCA-NASA Development of TIROS Advances Progress in Worldwide Weather Forecasting

From its vantage point in space, TIROS is sending down to earth new, more definite pictures and data of the world's everchanging weather patterns to aid man in his ageless efforts to control the elements.

Incorporating revolutionary and advanced electronic equipment, TIROS was designed, developed and built by RCA's Astro-Electronics Division for National Aeronautics and Space Administration. Within its small circumference are miniature TV cameras, tape recorders, TV transmitters, command receivers, timing mechanisms, beacons and telemetry equipment. In addition, it carries new scanning and non-scanning Infra-red Sensing Devices, developed by NASA, to measure and record the heat radiation of the earth and its cloud cover, and a revolutionary new Magnetic Orientation Device to capitalize on the effects of the earth's magnetic field and maintain favorable orientation of the satellite for long periods.

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Underwater Ordnance (Contd.)

Watch oceanography—both as a field for extensive technological development of new devices and techniques and as a growing market. Total government budget for oceanography jumps from $55 million in fiscal year 1961 to nearly $100 million in 1962; should hit $300 million by 1964. Everything is involved: Instrumentation, exploration, surface ship construction and outfitting, remote manipulators, maximum-depth subs, automatic recording buoys, ocean monitoring platforms, etc.

Submarines of tomorrow may look a lot different than those we know today and give a lot more sickening ride. However, if the observations of Dr. T. Yao-tsu Wu at California Institute of Technology are any criterion, they'll go farther and faster on much less energy than is now required.

Dr. Wu has been watching fish—both real and mechanical. Tentatively at least, he has determined that fins are for stability only; that body undulations provide propulsion by creating a wave-form pressure differential; and that fish encounter minimum viscous drag by maintaining laminar flow of the water past their bodies. As well as observing a range of undersea life from trout to porpoises, Dr. Wu has built and studied mechanical fish in water tunnels.

In case anyone missed it, Navy's Asroc (antisubmarine rocket, or rocket-boosted torpedo) has been declared operational after being successfully fired from the guided-missile frigate U.S.S. MAHAN, operating fifty miles off San Diego. A.O.A. members witnessed such a firing while at sea with the Navy off Long Beach during their 43rd Annual Meeting on May 17th. Feasibility of Polaris and Subroc underwater launching is being studied at depths down to 175 feet below sea level.

We're not sure what this has to do with underwater ordnance (it could be a human factor in submarine crew selection one day) but a tentative determination has been made relating the number of tattoos a sailor sports to his degree of maladjustment. Dr. Richard P. Youniss, (Lieut., M.S.C., U.S.N.R.) of Catholic University, Washington, D. C., describes this pictorial individual as "emotionally immature; proving that he is a tough guy; attempting to gain some indelible evidence of his identification with a rough-and-tumble masculine group; mixed up emotionally; the impulsive, over-aggressive type; in the lower intelligence range . . ."

Two 2-faced owls (stuffed) may be the remedy for too many seagulls that have a tendency to inundate unmanned oceanographic research platforms. Navy Electronics Laboratory seagull chasers haven't reached a final conclusion yet, but —after months under a variety of platform conditions including the staking out of two 2-faced stuffed owls, one 2-faced stuffed owl, with people on board and without people on board—preliminary indications are that people (busy) are a sure cure for ocean platform seagullitis; two 2-faced owls are a major deterrent; one 2-faced owl is of indeterminable value.

A fuel cell with table salt as a reaction product has been built and demonstrated by Hoffman Electronics Corporation. The sodium-chlorine cell, recently shown in a model little bigger than a wristwatch at Army Signal Corps' Power Sources Conference, produced an open-circuit voltage of 3.30 volts. Larger versions have been suggested as submarine power sources.

Torpedo recovery device, Solaris (swimming, TV-guided, unmanned, cable-operated vehicle developed by Vitro Laboratories) has passed all its tests successfully, including recovery of a coffee can at a depth of 650 feet.

New sub-hunter aircraft, Lockheed Aircraft Corporation's P3V-1 Orion, is now operational. A major modification of the Electra airliner, Orion carries magnetic anomaly, radar and sonar search gear, nuclear depth charges, and other ASW equipment.

Coordinated ship electronic design is Navy's latest program to increase the compatability of shipboard electronics systems. Under the program, design, development, and plans for installation of electronic equipment on the Navy's capital ships will be carried on concurrently and in close coordination with ship design and construction.

As a starter, Electric Boat Division, General Dynamics Corporation, will provide electronics system design for a nuclear-powered attack submarine; Hazeltine Corporation will do the same for a guided-missile escort vessel; and Alpha Corporation will supply electronics design for a guided-missile frigate. If results are satisfactory, this procedure will become standard for naval ship construction.

From Davy Jones' Locker

Problem in underwater instrumentation: Some Navy planners are beginning to feel like the inmate of a windowless medieval dungeon in which lurks an oubliette. Problem arises in developing reliable instrumentations for underwater installations big and small—such as Autec (Atlantic Underwater Test and Evaluation Center). States M. P. Wennekens, U. S. Naval Ordnance Test Station, China Lake, Calif.: "One of the more serious problems . . . is the thorough understanding of the marine environment and its influence upon the performance of various devices. . . . The oceanographic information of outside (of the Navy) agencies is usually too general."

Problem in kill range: Even though our underwater search and detection ranges are limited, they still exceed the range of the weapons that do the actual killing of another submarine. Nuclear weapons such as Lulu, Betty, and Subroc go part of the way toward filling this gap, but the Navy wants a greater family of long-range underwater weapons. And besides, range of detection gear itself is being increased.

Problem in modificationability: With the initial cost of major weapons platforms, such as nuclear-powered submarines, high and rising, the need increases to "design ships which have a sufficient potential for modification," according to BuShips Chief, Rear Adm. Ralph K. James. Designing the capability for modification into ships also means designing weapons systems and auxiliary equipment that can be kept current with technological progress.

Problem in fathometers: For precise Polaris submarine bottom tracking there is need for additional narrowing of the fathometer's beam so that only the depth of the ocean directly beneath the sub is measured—not that several degrees away.

Problem in damped hull construction: Navy has developed laminated structures which effectively dampen transmission of submarine-created noise to the surrounding environment. These usually consist of metals and nonmetals bonded together. Needed: Capability to fabricate greater variety of shapes and range of sizes that will do the job but still be pressure-tight.

Problem in oceanography (there are many): Navy has stated need for a fleet of ships that are strictly survey ships—constructed, instrumented, and used solely for that purpose. They should be capable of gathering data from any and all depths ranging from the oceans' greatest deep to shallow coastal areas. They should have precise surface-position-determining capabilities as well as a complete range of meteorological and ocean surface measurement instrumentation.

EDITOR'S NOTE.—For an over-all picture of the detection problem that the nuclear-powered submarine will cause, the reader is referred to the article, "Antisubmarine Warfare," by Rear Adm. H. L. Miller, on page 153.

NUMBER 9—INSTRUMENT SERIES

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MISSILE SUPPORT EQUIPMENT

Robert S. Sartoris

Missile Base Construction.—Amid hearings that produced at least as much heat as light, problems of the construction of ICBM bases have been thoroughly aired in congressional hearings and may yet result in the desired speed-up of construction while still giving the taxpayer a better break for his money. While nothing has been settled, the hearings are uncovering distinct problem areas, which is at least half the battle. There is little doubt that reforms will be made because of this.

Specific trouble spots are many. Contractors complain that their contracts are with the wrong people. They are signed with the Corps of Engineers, but much of the work involves direction by three other sources—the Air Force, the architect-engineer, and weapons systems prime contractors. As a result, lines of communication are unclear and confusion rife.

In addition, the contractors are, in many cases, dealing with tolerances and conditions not usually dealt with in the construction business. This is difficult enough, but, they say, in many cases the original design work is too slipshod, leading to a great many changes and revisions.

Labor trouble also has come in for a good bit of discussion, part of it caused by the age-old jurisdictional dispute between building-trade craft unions and men hired by the systems manufacturer as well as among various construction crafts themselves as to which trade should be assigned work not normally found on the construction scene. Labor has undertaken to police the situation itself to avoid possible Government intervention, and the building trades have approved a policy statement prohibiting strikes until all other procedures have been tried.

Offshore Facilities.—In anticipation of overcrowded conditions at Canaveral, the National Aeronautics and Space Administration is conducting industry competition for planning of huge facilities off the coast of Florida to accommodate advanced vehicles. Under study are both semi-offshore and offshore facilities that could employ large launchers, hydrogen-fueled and nuclear-powered vehicles. The plans require a close tie-in to existing services and logistic facilities where possible.

Semi-offshore facilities would be partly on the mainland, extending over the water or on an artificial extension of the mainland. This approach would permit maximum use of existing ground support equipment and facility designs, and the study includes a determination of the advisability of either minimum or maximum facilities being constructed over or beyond existing shorelines and whether access should be by causeway or by water vehicles through dredged channels.

Offshore sites offer the advantage of unlimited areas at no cost, remote location of launch facilities for special hazard protection, unlimited water for cooling jet-blast deflectors, and other economic and operational advantages. Studies will indicate favorable oceanographic and hydrographic conditions for establishing the new facilities in close proximity to Canaveral and will cover such concepts as fixed structures, semifixed floating vehicles, and drydocks. Free-floating structures are not under consideration in this study.

Major problem areas to be considered for semi-offshore facilities will be the effectiveness of shallow water as opposed to deep or unlimited water. Problems of offshore facilities include the hazards and difficulty of construction at sea, methods of transporting and transferring propellants, the need for stand-by fuel replenishing facilities, electrical power supplies, and potential expansion capabilities.

Considerable study also will be given to logistic plans including the design of multipurpose vehicles capable of transporting vehicles and propellants and supplies to the site and for safety factors involved in launch operation such as an emergency escape system for prelaunch disasters and a means of controlling fire in the event large quantities of burning fuel are dumped in an abort.

Both systems will be evaluated in detail on the basis of economics, operational and schedule requirements, simplicity, reliability, construction scheduling, support requirements, and safety.

Underground Titan Launch.—Underground silo launching of the Titan ICBM has been tested successfully at Vandenberg Air Force Base, Calif. A Titan I with dummy second stage "fueled" with water ballast blasted from its 146-foot-deep silo in a test of acoustical vibration and thermal shock experienced by the missile, a checkout of the range safety destruct system, and examination of the structural integrity of the missile airframe.

As programmed, hold-down provisions within the silo were released three seconds after ignition, and five seconds later the missile had cleared the silo. For the test shot the big bird rested at the center peak of a W-shaped exhaust deflector that was used to conduct hot gases away from the silo opening. Exhaust was conducted down the inner sides of the W, then reversed to emerge parallel to the direction of flight, generating temperatures in the order of 5,000 degrees Fahrenheit.

Integrated Checkout Gear.—The Navy, in attempting to standardize checkout gear, has contracted for a study of the feasibility of designing and building submarine electronic gear as a single integrated system. Present equipment is a patchwork of systems and components that tends to be confusing and is difficult to maintain.

Missiles or Vehicles?—Truck or tank-mounted missiles may be the next target for military thinking. Dr. Theodore von Karman, chief adviser to NATO on air research and development, is urging the move, saying that such bomb-heaving long-range missiles would be harder to knock out than any other type of missile including those that might be dropped from orbiting satellites. He believes that missile-toting submarines such as Polaris carriers will soon be extremely vulnerable as a result of the research now being conducted on antisub techniques. He also frowns on the use of railroad cars to launch ICBM's, as planned for Minuteman, because rail-based missiles can only remain as mobile as the amount of undamaged track will permit.

Trucks would be a better answer, he says, because they can travel the Nation's highways, which traverse much more of the country than do rails. Tanks would be even better, permitting travel over nearly any terrain, even where there are no roads. The United States has missiles that can be launched by vehicles such as trucks, but most of those are short-range weapons with lightweight warheads, designed chiefly for battlefield use.

Mr. Sartoris is on the staff of Boeing Airplane Company, Seattle, Wash.

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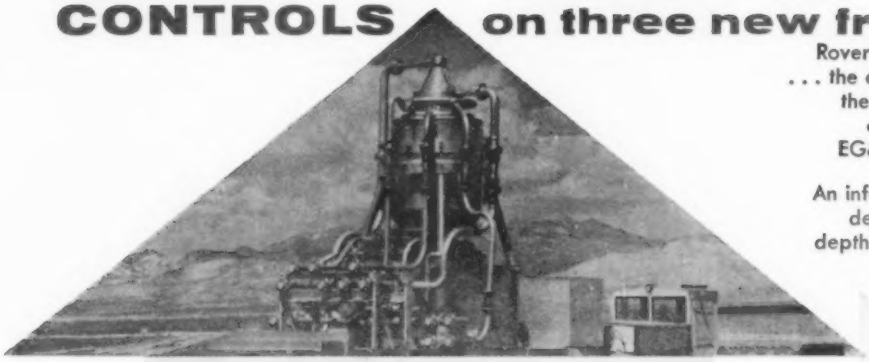

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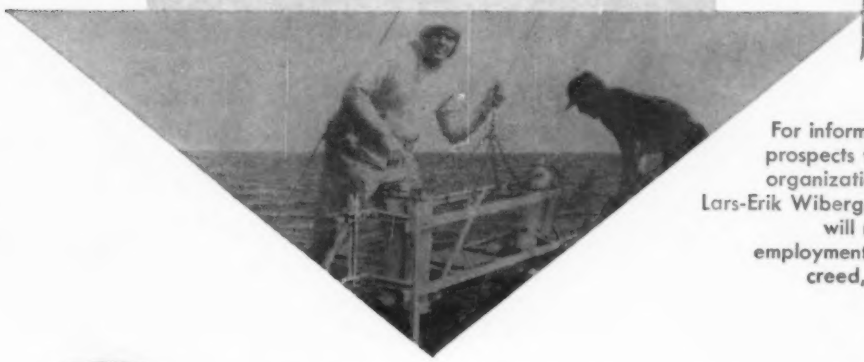

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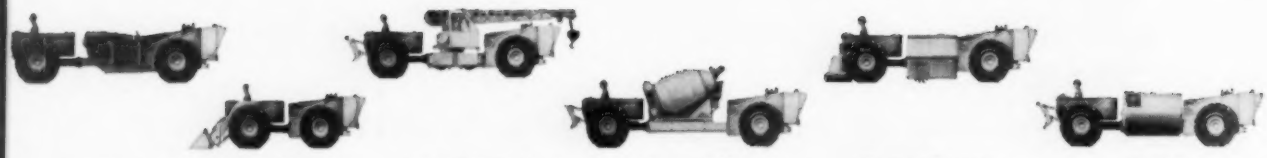

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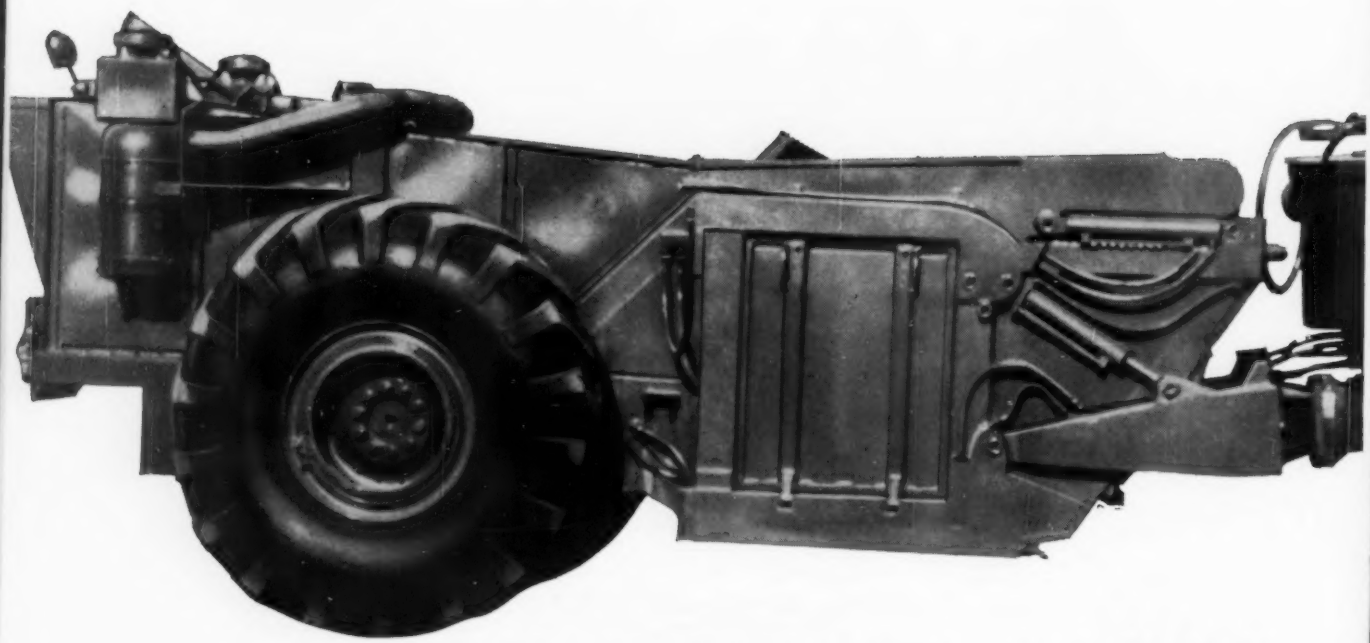

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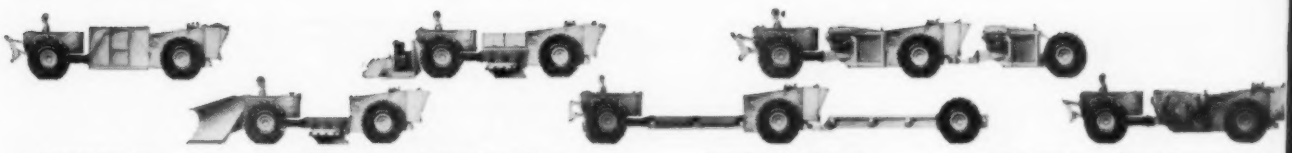

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MATERIALS PROGRESS

George S. Brady

Civilian Industry and Defense.—Recent discussion of comparative military potential, especially relating to our so-called "lag" on some military programs, has accented the fact that we have a number of large-scale civilian industries which are almost nonexistent in the Iron Curtain countries, but which in our economy compete directly with our military programs for materials, plant equipment, skilled labor, and scientific personnel.

Prepared food manufacturing, for example, is now one of our largest industries, and when to this great industry is added the manufacture of kitchen equipment and appliances, we begin to realize that our "way of life" imposes economic problems on our economy that do not occur in the planning of military programs in Russia or China. About 50,000 tons of aluminum were used last year in the relatively small item of cookware alone.

But it is quite clear, however, that we cannot cut down or eliminate these industries without destroying our "way of life." The foodstuffs-manufacturing industry, with its coordinate appliance industries, contributes most directly toward the high standard of living which we enjoy, not merely by providing us with better foods, but by relieving workers' families of much time-wasting drudgery.

It is said that there is much economic waste in these civilian industries through advertising propaganda that causes obsolescence by style changes that have no real technical value. But what we need to realize is that in general these industries are highly efficient in materials and methods developments, and they can be a great asset rather than an economic burden to military-industrial planning by increased coordination.

As one small example, recent food-industry research on sugar (sucrose derivatives) is now resulting in many products—plastics, shellac substitutes, etc., highly useful in other industries.

It is interesting to note in this connection that much of the development of bimetals and extremely accurate thin strip metals needed for electronics and for miniaturized missile components was pioneered in the costume-jewelry industry where the production of accurate small parts is daily routine.

In a recent congressional investigation it was brought out that the pharmaceutical industry had 7,200 persons engaged in research and development in 1960 at a total cost of $215 million. Many of the drugs developed in this research are highly complex chemical compounds requiring intricate methods of synthesis, and the scientific developments in materials and methods can be of great value in other industries.

Outwardly, there appears to be no relation between food mixes and missiles, but examination of the materials, methods, and equipment in the industries shows that such widely diverse products have fundamentally the same research and development problems.

New Corn Mill.—A new wet-corn mill developed by *Entoleter, Inc.*, New Haven, Conn., has two 40-inch-diameter rotor disks which revolve at 3,600 r.p.m. Corn fed through the center opening of the upper disk is crushed by impactors and thrown, as corn steep liquor, against the outer wall at a periphery speed above 30,000 feet a minute, breaking the internal structure of the corn granules and freeing the starch.

In addition to the high stresses from the speed of rotation and impact, there is an intense scouring action, or corrosion-erosion, from the corn particles in the steep liquor containing sulphurous acid—not unlike design problems frequently encountered by military engineers.

The impactors of the mill are forgings of Type 316 stainless steel, but the rotor disks were cast from a modification of Alloy 17-4 PH (Alloy Casting Institute). The modified alloy contains 16.5 per cent chromium, 4 nickel, 4 copper, and 0.05 carbon. When precipitation-hardened, it has a tensile strength of 179,000 pounds per square inch with elongation of 4 per cent. Stationary parts of the mill were cast from Type CF-8M stainless steel containing about 2.5 per cent molybdenum for protection against the corrosive action of the steep liquor.

Aluminum Cans.—During World War II the heaviest demands for the scarce metal tin were from the food-packing industries for tin plate and solder. This year it is estimated that *Minute Maid Corporation*, Auburndale, Fla., alone will use 50 million aluminum cans for packing citrus juices. The one-piece extruded can, such as was developed for beer and lubricating oil, is not being used for this purpose.

The new aluminum cans are being made from coated and printed sheet, with tops and bottoms seamed on and sealed with synthetic resin cement without solder. Only minor changes were needed in standard can-making machines to compensate for the lighter weight and with vacuum pickup for the nonmagnetic aluminum.

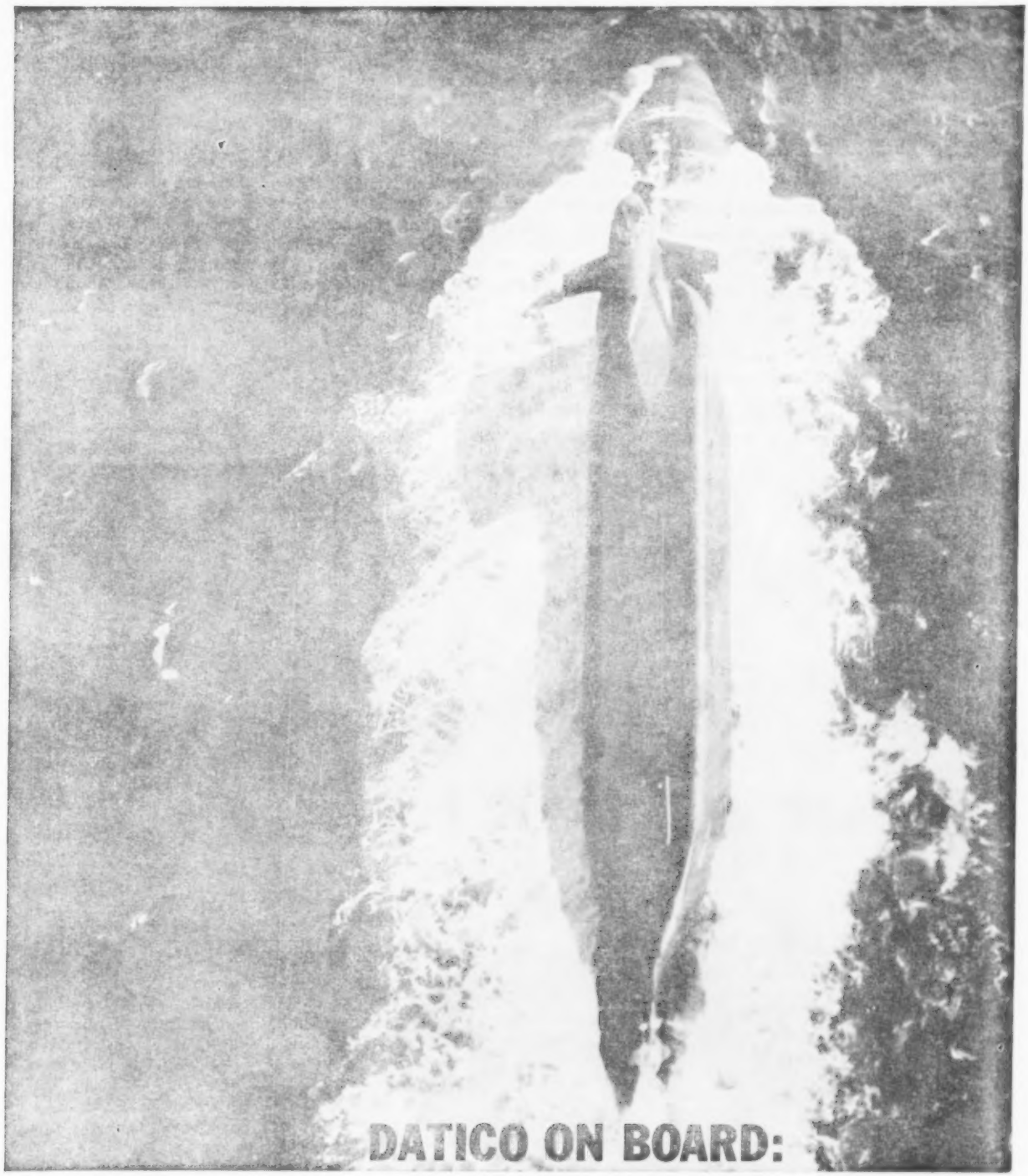
New aluminum food cans of the *Central States Can Corporation*, Massillon, Ohio, also are blanked and formed from precoated sheet. No solder is employed, and the cans are opened easily by simply pulling off an aluminum tear strip.

Plastic Truck Tank.—A new design of tank truck developed for Standard Brands, Inc., by the *Crompton & Knowles Packaging Corporation* for hauling vinegar and other corrosive liquids, has the 4,500-gallon tank made of solid fiber polyester resin laminate. The tank is a self-supporting structural tube divided into three compartments for separate liquids, and has no other bracing. Operation and maintenance costs are reported as twenty per cent lower than for stainless-steel tanks.

Polypropylene Tubing.—For use in food-processing equipment and in the chemical industry, *Imperial-Eastman Corporation*, Chicago, Ill., has a new line of stabilized polypropylene tubing which is resistant to boiling sulphuric acid and to concentrated hydrochloric acid, and gives good resistance to alkalies at temperatures above 212 degrees Fahrenheit. The tubing is stated to be serviceable at working pressures three times higher than those possible with nylon tubing.

Plastic Trays.—Large savings were made at the confectionery plant of *W. F. Schrafft & Sons*, Charleston, Mass., by the replacement of wooden trays with plastic. The company uses 100,000 trays in the production lines. The new high-density polyethylene trays, molded in one piece, weigh only half as much as the

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.



DATICO ON BOARD:
SIX MONTHS FROM CONTRACT TO COUNTDOWN

Just six months following contract award, Northrop began deliveries of Datico automatic checkout equipment for use in the Navy's Polaris Fleet Ballistic Missile program. Datico is used in factory, depot, tender, and submarine operations.

Datico is a digital automatic tape checkout system with a wide variety of applications. Its successful integration by Northrop into the Polaris and other major weapons systems demonstrates that the same basic Datico equipment can be used at all levels of maintenance and operation, utilizing the same test standards and methods and operated by personnel with the same basic training.

Northrop is at work on more advanced versions of Datico to extend its capability to an even wider range of military and industrial systems.

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former wooden trays, are more shock-resistant, have rounded corners to eliminate collection of impurities, permit unlimited hot-water sterilization, and are stackable.

Versatile Beryllium.—Beryllium is becoming a preferred metal for many uses in high-speed aircraft and missiles, but its relative scarcity and high cost militate against its employment for civilian products. Wth a tensile strength above 100,000 pounds per square inch and a specific gravity only about one-quarter that of steel, its structural strength-weight ratio is equal to a steel that would have a tensile strength of 450,000 pounds per square inch. Its stiffness is also 25 per cent greater than that of steel.

It resists oxidation to 1,500 degrees Fahrenheit and retains 50 per cent of its yield strength to 1,000 degrees. Beryllium also has a very high specific heat factor, more than four times that of titanium, so that it is useful as a heat sink to absorb frictional heat from high speeds.

There are those who say that the supply of beryllium is sufficient to meet demands, but actually the potential demand is suppressed by the high cost, which, in some of the desired finished sheet forms, ranges higher than costs of the precious metals. There is a large potential demand for the metal which would become an actuality if an assured supply at lower cost were possible. There is also a large potential market for beryllium-oxide ceramics for high-temperature shielding and for electronic uses. Beryllium also is valuable as a booster for rocket fuels and explosives, but the present cost and relative scarcity exclude it from this use.

In case of a war emergency, demand for beryllium would expand rapidly. The answer does not lie in stockpiling. The Bureau of Mines already has demonstrated that ores with as little as one per cent beryllium oxide can be concentrated, and laboratory work also has shown that some of the low-grade ores can be acid-leached—not possible with conventional beryl ores.

Beryllium occurs in more than thirty minerals, and there are large domestic deposits of a number of these minerals. The real answer to the supply and cost problems appears to be in devoting more research funds to the study of new methods of extracting the metal from its ores.

Insulating Materials.—At the other extreme of the materials picture is mica, to which much stockpiling attention has been given. Natural mica no longer has the strategic importance that it had during World War II. Besides the continuous uniform mica sheet produced from both natural mica flake and synthetic mica flake, with or without a binder, innumerable other substitutes are available at the present time.

Rogers Corporation, Rogers, Conn., now has a new one, a rag paper with a nylon film extruded directly on it, giving a high-dielectric sheet without the use of an adhesive. *National Vulcanized Fibre Company*, Wilmington, Del., also has a new insulating sheet, called Anilite, available as thin as 0.004-inch. It has the strength of vulcanized fiber, and the low moisture-absorption rate of a phenolic laminate.

A new plastic insulating sheet of the *Pennsalt Chemicals Corporation*, Philadelphia, called Kynor, good for temperatures to about 350 degrees Fahrenheit, has a dielectric strength of 1,280 volts per mil. It is a vinylidene fluoride, $(CH_2{\cdot}CF_2)_x$. The great advantage of mica substitutes is that they come in continuous uniform sheets adaptable to production methods.

Fibrous Metal Gaskets.—Under an Air Force contract, *Armour Research Foundation*, Chicago, Ill., has developed a fibrous metal for gaskets and O-rings which provides tight seals at high pressures and temperatures. The material is made with a skeleton of stainless steel or other resilient metal fiber and then impregnated with a filler of magnesium or other soft metal to give conformability. It was designed primarily for use in hydraulic systems to withstand pulsating pressure of 5,000 pounds per square inch at temperatures to 1,200 degrees Fahrenheit.

New Lead Alloy.—Another new wrinkle in metal technology has come out of research at *Micronized Metals, Inc.*, Long Island City, N. Y. The research on exothermic reduction of metals from solvent solution was undertaken with the idea of obtaining pure metal powders of submicron particle size. But from a solution of lead and alumnium salts the company states that it has obtained a lead "alloy" containing submicron particles of aluminum oxide, Al_2O_3, evenly dispersed in the lead matrix. The alloy thus obtained has a greatly increased structural strength compared with lead, with no reduction in the corrosion resistance.

Uranium Tool Steels.—The Canadian Department of Mines, Ottawa, has developed a series of uranium tool steels of high fatigue strength and improved physical properties. Only small amounts, 0.01 to 0.05-per cent, of uranium remain in the steels. It is stated that the steels have been patented, but the idea is not new, as at least one American company was producing uranium steels before restrictions were placed on the use of uranium during the war. Uranium is a powerful deoxidizer as well as a carbide-forming agent in steel.

Lightweight Barges.—*Reynolds Metals Company* is pushing the idea of aluminum barges for transporting chemicals. The first of the all-aluminum barges, being built at the *Todd Shipyards*, Houston, Tex., to transport chemicals from the Texas plant of the Diamond Alkali Company, will be 98 feet long, 35 feet wide, and weigh 86 tons. Light weight per load unit, chemical-corrosion resistance, and low maintenance costs are the big factors.

Anodized Aluminum.—In the development of the Image-orthicon camera, *RCA Laboratory* scientists gained some new insights into the physical properties of anodized aluminum which may be useful in other applications. The camera target consists of nickel plugs embedded in a diamond-patterned insulating film of aluminum oxide obtained by anodization. There are 750 to 1,000 plugs per linear inch, and the oxide prevents lateral leakage of the secondary electrons which are ejected when the photocathode electron stream strikes the target.

On the target a pattern of positive charge results which is a replica of the optical image projected on the photocathode, and these secondary electrons are collected by a fine-mesh metal screen mounted close to the target. The anodized oxide coating makes the target capable of storing patterns for many seconds for memory plates.

The point of interest here concerns the physical differences in the oxide films which are deposited. It was found that when aluminum is anodized in an electrolyte of sulphuric, phosphoric, oxalic, or chromic acids a porous oxide is formed which is much heavier than the nonporous films formed in ammonium citrate, tartrate, or borate solutions, but the pores are holes a few hundred angstroms in diameter perpendicular to the aluminum surface. However, a nonporous barrier film can be grown next to the base metal to a definite thickness set by the electrolyte and the anodization potential.

New Lubricants.—The high-pressure lubricant, molybdenum disulphide, has an acid reaction (the pH is 3.4 to 4.9) which tends to corrode metal bearings. But now, the *McGee Chemical Company*, Upper Darby, Pa., has a group of lubricants, called McLube, which consist of molybdenum disulphide coated with silicon-alkyd, silicone-phenolic, or other resin to bring the pH to about 7 and reduce corrosion. They can be used at temperatures to 700 degrees Fahrenheit.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Nuclear Rockets

For a preliminary moon objective and the near planets (Mars and Venus) as our ultimate objective, nuclear rockets would have to be the major propulsion effort of the U.S. According to NASA's H. B. Finger, chemical systems will probably lead the nuclear systems at least for lunar missions. Nuclear systems, however, should provide a backup for a manned lunar landing which would cost about $15-30 billion.

At the present time, a nuclear third stage for Saturn is visualized. A one-half to two-thirds weight reduction in lunar landing vehicles could result by using nuclear stages. With Saturn, however, nuclear stages have to be used in connection with an orbital rendezvous. Saturn now being developed would require more than six units to assemble the lunar chemical combustion spacecraft.

Combination of chemical and nuclear systems in the Nova configuration could allow direct flights to the moon. A 4,000-megawatt reactor as third stage would allow a first-stage thrust of only 4.5 million pounds rather than the 10.5 million pounds for an all-chemical rocket.

Several problems associated with nuclear rockets have been given recently. In Douglas Aircraft Company's RITA (Reusable Interplanetary Transport Approach) a million-pound-thrust nuclear rocket engine is buried in its liquid hydrogen tanks. Here, boil-off of the liquid hydrogen working fluid is a serious design consideration.

An Oak Ridge Laboratory study indicates that hazards of the first-generation space reactors (under one megawatt thermal) can be small. Two conditions of concern are an abort on the launch pad and breakup in ballistic trajectory.

The possibility of using nuclear rocket coolants for braking a recoverable nuclear rocket has been investigated by Aerospace Corporation. The extra propellant can be expelled and used for reentry retrobraking. However, the effect is weak, and aerodynamic braking also is required.

A nuclear nozzle of flight weight is under development by the Rocketdyne Division of North American Aviation, Inc. The nozzle is made of Inconel X tubes, will handle liquid hydrogen, and is to be used on Kiwi-B tests at the AEC Nevada test site. Heat loads of eight to ten times that of chemical nozzles will be handled by the nuclear nozzle. Kiwi-B will be ground-tested late in 1961 and early in 1962. In addition to the nozzle, an axial-flow turbopump for the nuclear rocket has been operated in tests for periods of over 35,000 seconds.

Liquid Rockets

The NASA large engine test complex, costing $15 million, has been activated at Leuhman Ridge, Edwards Air Force Base, Calif. The F-1, single-chamber, 1.5-million-pound-thrust rocket is to start full-scale field tests here.

First large stand completed was 2-A, and it has been used for several months. It was on this first stand that a new high thrust record of 1.64 million pounds was attained on April 6, 1961. Next complete l was Test Stand I-A which will be used for static test of the full F-1 engine.

Next stand is I-B which towers 250 feet over the desert floor. It is on I-B that a cluster of F-1 engines can be tested. This huge stand has a liquid-oxygen capacity of 75,000 gallons and a fuel tank capacity of 60,000 gallons.

Each F-1 engine will consume propellant at the rate of three tons a second. A turbopump delivering about 60,000 horsepower feeds the propellants into the hungry engine.

Another large static test stand is to be ready soon. The NASA Marshall Space Flight Center has awarded a $4.8 million contract for final design of its new $10.3 million static test facility for the Saturn rocket. Design is to be completed in six months. Procurement, fabrication, and instrumentation will be finished in about a year and a half.

The facility will be located at Huntsville, Ala., and foundations for the tower will be laid this summer. A static test stand, a reenforced-concrete control center, control and instrumentation tunnel, and a fuel and liquid-oxygen system make up the facility.

Joshua is a new, lightweight liquid rocket ICBM now under study and development by the Rocket Test Agency of the Air Force Systems Command at Edwards Air Force Base, Calif.

A standard Air Force Titan ICBM made its first launch from the bottom of

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

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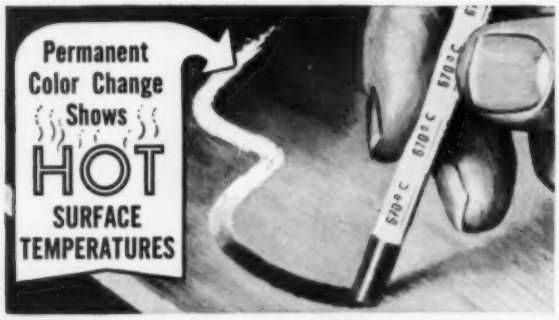

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- The Index to Volume XLV of ORDNANCE also is now available. It is arranged alphabetically by subject and author with title page for binding and covers issues No. 241 (July-August 1960) to No. 246 (May-June 1961) inclusive.

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Rockets & Guided Missiles (Contd.)

a 146-foot-deep underground silo at Vandenberg Air Force Base, Calif. The first-stage thrust was 300,000 pounds. For this silo launch, the exhaust flames (over 5,000 degrees Fahrenheit in temperature) are deflected upward through special ducts and released at the surface of the ground and parallel to the missile's flight. Titan I squadrons will be raised to the surface prior to launch. Titan II, using storable propellants, will fly out of the silo under its own power. The test, however, used cryogenic Titan I propellants.

Decision on the new Atlas-G booster still has not been made. New H-2 engines could give a total launch thrust of 560,000 pounds or 660,000 pounds. The former, with Centaur second stage, could put 18,000 pounds into 300-mile orbit or 3,500 pounds into a 24-hour orbit. The larger thrust, also with Centaur, could put 20,000 pounds into a 300-mile orbit or 4,000 pounds into the 24-hour orbit. Without Centaur, the G version could put about 4 tons into a 300-nautical-mile orbit.

First view of the second-stage Centaur rocket was given recently. To be used with the Atlas-D booster, the first Atlas-Centaur is slated for launch in November. By the end of 1964, some 15 vehicles will be launched. The second stage gets its power from two 15,000-pound-thrust liquid hydrogen-liquid oxygen rocket engines.

Two new developments may have far-reaching implications for future large-thrust liquid rocket engines. In test at Pratt & Whitney Aircraft, East Hartford, Conn., is a vectorable plug nozzle. In this technique, a number of rocket engines are clustered around a truncated cone plug. The method allows thrust direction control, throttling, and multiengine safety features. Propellants used in the tests were nitrogen tetroxide oxidizer and unsymmetrical dimethylhydrazine.

Propulsion engineers at the University of Michigan have been working to harness the detonation of hydrogen and oxygen mixtures. Their device is called a rotating detonation engine. In a circular groove cut into a metal block, a hydrogen and oxygen mixture is introduced and detonated. The detonation proceeds around the path at supersonic speeds.

The high energy release rates (100 times that of standard rocket engines using the combustion process) could give an engine of 1.5 million pounds' thrust in a detonation area of only 1.4 square feet or an over-all engine diameter of only 6 feet. The detonation engine, however, is still in an early phase of development.

Solid Rockets

Big solid rockets have been in the news and (along with nuclear rockets) are being proposed as a way for the U.S. to catch up in the rocket race. On May 9, 1961, Aerojet-General Corporation announced the successful firing of a 25-ton subscale unit representing the largest known segmented solid motor. The unit was 65 inches in diameter, produced 160,000 pounds of thrust, and was made up of 2 cylindrical segments locked together. The firm has proposed a huge 17-million-pound-thrust solid engine which could burn for over a minute and put 7 million pounds into space. It woud take thirty months to produce such a rocket.

A super solid rocket which could launch an Apollo-type vehicle has been suggested by Hercules Powder Company. A design of 6 sections has been proposed for a multimillion-pound-thrust rocket which would be 50 feet high and weigh over 30 tons.

Soon to be fired is a 250,000-pound-thrust conical segmented motor by United Technology. Under NASA contract, three segments will be used. Burn time is over one minute and total weight is over 75,000 pounds. The motor could be scaled up to deliver 3 million pounds of thrust; clustering these units could give a booster of 15 million pounds' thrust.

The Army's 2-stage solid rocket, Pershing, made a successful flight in which it exceeded the range of the Redstone missile (a liquid rocket which it is to replace), although the Pershing was preset to cover less than maximum range. The inertially guided

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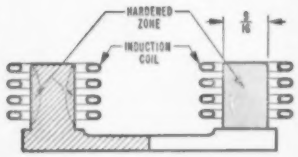

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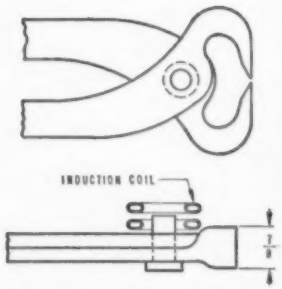

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missile carried a new tapered nose section and was fired from its mobile transporter-erector-launcher which was mounted on a tracked prime mover. The Pershing also is designed to be transportable by either airplane or helicopter.

Canada has revealed a series of solid rockets to be used for high-altitude studies. Black Brant II can send 150 pounds of instruments to altitudes of 150-180 miles. The launch weight is 2,782 pounds, and total length of the rocket is 27½ feet. Thrust is 16,000 pounds for 26 seconds. Future models by the Armament Research and Development Establishment will be abe to send payloads of 250 pounds to altitudes of 600 miles. Eventually, solid missiles will give Canada orbital capabilities.

Nike Zeus

Nike Zeus, the antimissile missile, could be extended in range to give an antisatellite capability. The Army said that minor changes could give a range of 200 miles and that with major changes, the "anti" system could be extended to vertical ranges of 1,200 miles. The latter range, the Army believes, could be achieved by 1967.

Meanwhile, it was reported that the present Zeus program is on schedule. The present Zeus weighs about 22,000 pounds at launch and has a launch thrust of 450,000 pounds, giving an initial acceleration to the missile of about 20 G's. During flight, accelerations will increase as propellant is burned.

First tests of the Zeus will be made against a 3-staged Speedball solid rocket which has a maximum speed of 8,000 feet a second, an altitude capability of 180 miles, and a flight range of 40 miles.

Funding of the Zeus program has been about $750 million and work is nearly complete on the Kwajalein test base. This fall, flight tests of the Zeus will be made from Point Mugu and will check out guidance, control, and first-stage propulsion.

After the preliminary Speedball tests at Kwajalein in March 1962, a series of Zeus missile tests from silo launchers is planned. Targets will be Atlas missiles to be launched from Vandenberg Air Force Base, Calif., and the Zeus crews are to receive no advance warning of the ICBM firings. Also, the Air Force has been instructed to use whatever countermeasures, including decoys, it can devise by test time.

The base at Kwajalein is a $75 million facility and has four launcher cells and one target-tracking radar. The target island will be Eniwetok. In addition to being abe to "see" missiles coming from the U.S., the Kwajalein facilities will be able to look northwest to detect Russian missiles.

Electric Rockets

For many types of missions, electric rockets appear to be the only practical propulsion method. For unmanned missions to deep space (such as near the vicinity of the planet Jupiter) electrical systems have advantages over chemical systems.

Ion propulsion, using electrostatic acceleration, thus far has received more attention than electrothermal or electromagnetic means. Beam neutralization with limited earth-bound vacuum facilities, however, will mean that the devices currently under development will have to receive their first true tests in space. One of the limitations even here, however, will be that of supplying the electrical devices with power.

The Scout will be the first carrier rocket. NASA reports that about twenty Scouts, carrying ion engines (and later some magneto fluid mechanic and arc-jet engines) will be used in the 1962-1965 period. The Scout tests, however, will be short term and will be followed by long-term tests in space and in larger satellites. SNAP-2 and Sunflower power sources will be used and will supply about 3 kilowatts of energy during tests in 1963-1964, and SNAP-8 will power a 30-kw. ion engine in 1965. Atlas-Centaur will be used as the launching vehicle.

The arc rocket, now less well known than the ion rocket, is considered to have the highest thrust-to-power ratio of electrical systems. The arc rocket might be used in position and attitude control of space missions, cislunar space orbital transfers, and supply missions. However, studies at the Marshall Space Flight Center, NASA, indicate that the arc engine does not look suitable as the main propulsion system for interplanetary flight.

Problems of present arc jets include: heat transfer, energy balance, and anode drops. Again, power supply is a major item. Present arc engines under development have thrusts of 0.01- to 0.5-pound; the latter thrust will be given by SNAP-8. Power source levels of one megawatt and higher would make a 20-pound-thrust arc engine practical.

First arc engine will be flight-tested in late 1962, via a Scout vehicle, with a thrust of 0.01-pound and a power of one to two kilowatts. Operating time will be thirty minutes since first tests will be made with battery power. For interplanetary flight, however, operating times would have to be continuous for weeks and months. For trips beyond our solar system, operating time would have to be tens of years.

Consideration of the ion rocket, the arc rocket, and other forms of electrical propulsion emphasize the great need for further research in this field.

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ARMAMENT ELECTRONICS

Traver B. Van Vliet

Ground-Air Communications.—Air Force Cambridge Research Laboratories tests have indicated the feasibility of using ionospheric scatter for 2-way ground-air communications at ranges exceeding 1,000 miles. Operating at about 50 megacycles, an AFCRL station near Bedford, Mass., was able to maintain teletype communications with a specially outfitted KC-135 turbojet tanker at a range of 1,200 miles.

Ranges of up to 1,500 miles were obtained under favorable conditions, or at the expense of an increase in the error rate. The ground station's power output was 50 kilowatts. The aircraft was outfitted with a 5-kilowatt transmitter and two 10-kilowatt transmitters, the most powerful ever operated aboard an aircraft.

Long-Range Telemetry.—A new long-range airborne telemetry system has been developed by General Electric Company. The system, called Synchrolink, is a digital telemetry system employing pulse code modulation with phase shift keying (PCM/PS). According to the company, the system has a range three times that of any telemetry system yet flown.

Optical Radar.—A "light-beam" radar for many scientific explorations, including mapping the moon more accurately than before, has been developed by Hughes Aircraft Company as a research companion to its new Colidar spacecraft radar, as noted in the May-June 1961 issue of ORDNANCE.

Eventually an optical radar operating from earth could spotlight its beam on a moon area only ten miles in diameter. This would make possible sharper pictures than those now made by "illuminating" the moon with radio or microwave signals from ordinary radar which disperses its beams over such large areas that their intensity is dissipated. The radar has exceptionally high angular resolution, and, although still in early stages of development, it produces a beam one hundred times as narrow as the signal from conventional radar. In outer space there are no clouds or atmosphere to absorb the radar's optical beam. But even on the ground in the earth's atmosphere the device can distinguish between two adjacent 10-foot-wide objects five miles away.

The key part of the radar is its light source, a "laser" (for light amplification by stimulated emission of radiation), which produces an intense burst of pure red light in a narrow beam. For radar operation, a short pulse of laser light strikes a target. The light reflects back from the target into a telescope, where it is detected by a light-sensitive phototube. The time needed for the light burst to make the round trip provides an accurate measurement of the distance of the target.

The radar can operate in scattered sunlight or other illumination because a red filter in the receiver blocks out all kinds of light except the precise color of the laser beam. This permits the device to function better in daylight than previous optical radars, which use white light.

The company expects improvements in the radar's design and further development of the laser to enable the experimental system to operate at much greater distances than those achieved up to now —two miles in full sunlight and seven miles at night.

Visually Guided Missile.—An air-to-surface missile capable of locking on a TV or visual image of a target has been developed by the Hallamore Division of Siegler Corporation. In an aircraft, the pilot would select the target visually or from a TV display and the aircraft-carried missile would home on this. If the aircraft were pilotless, the battlefield commander would select the target from a TV image relayed to him from the drone.

Jet Engine Analyzer.—An airborne jet engine analyzer system is being tested by the Air Force in a Boeing B-52 and a Convair F-106. The system is designed to save maintenance time by indicating trouble spots and reducing the need for engine removals. The system was developed by Howell Instruments, Inc.

Three-Dimensional Radar.—The first known radar display device to present a progressive three-dimensional picture of the trails of aircraft under surveillance by an operating radar has been revealed by Hughes Aircraft Company. The display, called "Stereoscan," because it provides depth perception enabling the viewer to distinguish altitude separation among target trails as well as their range and bearing, was shown operating in connection with Hughes 3-D Frescan radar.

This radar is now being used by the Navy on ships at sea and is similar to the company's Frescanar 3-D system now deployed by the Army with Missile Monitor in Europe.

Airborne Atomic Clock.—An airborne atomic frequency standard has been produced for the Air Force's Wright Air Development Division by the National Company. The device, weighing only 62.5 pounds, is the smallest atomic clock ever produced. Earlier laboratory models developed by the company weighed about 600 pounds.

Interplanetary Magnetic Field.—Information provided by the Explorer X space vehicle has revealed an interplanetary magnetic field several times stronger than had been anticipated. Scientists of the National Aeronautics and Space Administration are currently reducing the data to provide precise measurements over the flight profile. The information will be used in planning future manned space flights and in studies of solar-earth plasma relationships.

High-Power Tropo-Scatter.—A high-power tropospheric scatter transmitter developed by Radio Engineering Laboratories is expected to permit ranges between terminals twice that of most existing systems. According to the company, the power output of the system is seven times that of any FM tropospheric-scatter transmitter ever built.

VLF Satellite Relay.—According to tests conducted by the Naval Research Laboratory in conjunction with its Lofti satellite, very low frequency radio could be used for space-vehicle guidance and for communications with submerged submarines by way of satellite relay. As VLF signals are able to penetrate water and ice, the Navy has employed them for communications with submarines. However, the use of these frequencies on

Mr. Van Vliet is a student of engineering and mathematics. He is active in amateur radio and also in experimental electronics.

a global basis has required highly expensive and powerful ground stations. In the tests with the Lofti satellites, VLF signals were transmitted to the satellite from a ground station located in the Panama Canal Zone and rebroadcast at VHF frequencies to NRL and NASA ground stations. Current Naval Research Laboratories plans are to launch three or four more Lofti satellites.

Superpower Tubes.—The Department of Defense has initiated a program to encourage and coordinate applied research in superpower tubes for use in deep space probe tracking and the detection and tracking of ICBM warheads. Programs are being sponsored by the Advanced Research Projects Agency, Army, Air Force, and the Department of Defense.

More Efficient Transistors.—A research program aimed at the development of a smaller, more efficient silicon switching transistor has been launched by CBS Laboratories under sponsorship of the Army Signal Research and Development Laboratory. Goal of the program is to cut internal power losses which would permit more dense packaging without the usual cooling problems.

Transit Solar Cells.—The Applied Physics Laboratory of the Johns Hopkins University has selected Hoffman Electronics Corporation to provide solar power supplies for a forthcoming series of the Navy's Transit navigational satellite experiments. In addition to manufacturing all the solar cells for the space beacons, the company will provide one half of required satellite power panel assemblies.

Optical Space Tracking.—General Electric Company is currently developing a combination of a high-power telescope and high-sensitivity television tube for use in optical tracking of space probes. The visual tracker is intended to be used in conjunction with other devices such as radio telescopes. The system offers the advantage of being able to track a space vehicle in the event its transmitters should cease to function.

Automatic Photo Inspection.—According to tests carried out at Cornell Aeronautical Laboratory, a perception-type instrument could be used to scan the large number of photos produced by a military reconnaissance or meteorological satellites, picking out those photos which are of potential value. These could then be analyzed by human operators. Tests were sponsored by the Office of Naval Research.

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FROM THE RECORD

The Defense Program

ROBERT S. MCNAMARA
Secretary of Defense

IN developing our new defense program, I received two basic instructions from the President:

1. Our own national security and our contributions to the reduction of international tensions depend on our military strength. Therefore, our defense program must not be constructed within arbitrary budget ceilings.

2. While the size and composition of our military establishment is being examined and reexamined to make sure that it is adequate and up to date, at the same time every possible effort must be made to eliminate waste, duplication, and unjustifiable expenditure.

In the light of the President's instructions, we have begun to reappraise the defense strategy of the United States, our capacities and our plans. We have completed the preliminary appraisal in the limited time available to submit a revised defense budget to the Congress for the coming fiscal year. This appraisal was a joint work project of the best minds, military and civilian, that we have available in the Department of Defense.

Our predecessors did a thorough job in preparing their program. As a result of the work we were able to do, however, we have reached different conclusions in a number of areas. In these areas we have already taken certain initial steps. We have accelerated our procurement of Polaris submarines, and we have moved to increase our airlift capacity. . . .

Over the years, we will continue to make major changes in the pattern of defense spending. We cannot afford to modify these decisions to accommodate local or private interests, no matter how legitimate. But we have an obligation to take steps to mitigate their consequences for the people affected.

At this point I want to mention two common assumptions which are, in my judgment, wholly fallacious.

First is the assumption that our economy is not strong enough to maintain large defense expenditures over a protracted period. I have no doubt that, if required, we can continue to sustain defense expenditures at their present levels, or, indeed, at increased levels, if this should be necessary. We can and must expend whatever is needed to protect the lives and substance of our people.

Secondly is the assumption that our economy is dependent upon large defense expenditures. I am equally certain that this assumption is false. We all earnestly hope that the day will come when we can substantially reduce the portion of our national wealth devoted to the production of instruments of war. I am confident that when that day arrives, far-sighted planning will permit that portion of our wealth now committed to national defense to be shifted to the improvement of the well-being of our people without serious disturbance of our economic life.

The future is, of course, uncertain. But of one thing I am sure—whatever the future may bring, our economy is strong and resilient enough to meet any challenge that may arise. . . .

Within the Department, our planning must extend further into the future in order to provide a lead time sufficient to permit adjustment to the future consequences of present decisions. Our choice of weapons must reflect the most imaginative exploration of all the choices available to us. Our budgeting procedures must be revised to show us all the costs of alternative weapons systems, not only for research and development, and for initial construction, but for operation and maintenance as well.

We must be bold enough to grasp distant opportunities, but we must be prudent enough to hedge our bets. Where we can, with reasonable assurance of success, buy time by committing ourselves now to long-lead items, or to production facilities, we must do so. We are proposing to contract now for facilities to double our Minuteman production capacity, thereby providing insurance against a future requirement.

This kind of planning will enable us to predict a little better the pattern of defense spending, but it will not avoid shifts in the spending pattern. The purpose of our planning is not to produce a Maginot Line, even in outer space. It is rather to maintain the kind of alert, flexible posture that can respond immediately to new developments in technology at home, or to new insights into the plans and capabilities of our potential enemies abroad.

We can continue to expect, therefore, that there will be major shifts in our defense program from year to year, and perhaps more often. Indeed, I think there would be real cause for concern on your part if you saw that our defense program over the next four years was following precisely the pattern that has just been set for it.

If change is the law of the universe, it is a law enforced with particular stringency in military planning. The penalties for failure to observe it are unavoidable and harsh. The President's defense program is designed to improve the capacity of the military establishment to adjust to changing military needs. It is also designed to reduce the impact of these changes on the economy. . . .—*Before the Associated Press, New York, N. Y.*

Our Military Posture

GEN. GEORGE H. DECKER
Chief of Staff, United States Army

IN developing a military posture we must ensure for our statesmen a position of strength which provides them a wide range of alternatives. We must avoid ever being in a position of having to choose between surrender or suicide. We must be able to respond with the type and amount of military force that is appropriate to each specific challenge presented. We must demonstrate to the free world—and to our opponents—that we have these flexible means, and most important—that we have the will and determination to use them if we must. Weakness in any capability invites aggression. . . .

Let me suggest the fundamental military capabilities we must possess. First, we must have a balanced combination of secure, strategic, long-range nuclear strike elements supported by active and passive defense measures necessary to ensure national survival.

The capability of our strike forces must be so evident that there is no doubt in the mind of any potential aggressor that we have the means to destroy him. Obviously, these strike forces must be invulnerable and reliable: Invulnerable to the degree that our opponents—and our allies—know that these systems can survive an enemy first strike, then penetrate his defenses and inflict unacceptable destruction upon him; reliable to the degree that no accident could occur by which a nuclear-tipped missile would be delivered unintentionally on the heartland of another nation.

(*Continued on p. 130*)

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From the Record (Contd.)

Secondly, we must have land, sea, and air forces that are capable of fighting with or without nuclear weapons. These forces must be "balanced," or capable of being combined most effectively to engage—and ultimately defeat—similar enemy forces in either limited or general war. A substantial portion of these forces should be deployed overseas at all times.

Finally, we must have long-range air and sea lift swiftly to project our military strength abroad—or to reenforce our forces already deployed.

These military forces will give us the necessary posture to meet any type of enemy threat. They also will provide the means to counter successfully a growing challenge that is presented in the form of subversion or belligerency below the level of open warfare. . . .

Positioning of our forces overseas as a principal means of executing our forward strategy points up a fundamental change in our Nation's foreign policy that has occurred since World War II. Before that war we had pursued a traditional peacetime policy of "no foreign entanglements." However, after World War II, the aggressive designs of the Communists became all too clear. The aftermath of World War II left many nations as inviting vacuums to be exploited by emerging Communist imperialism.

To counter this threat we joined with other free nations in a collective effort to preserve our freedom and independence. A major step in execution of that policy involved the forward stationing of our military forces where they could assist our allies in repelling military aggression should it occur.

In contributing to these forward deployments, more than forty per cent of our Army is overseas. Strategic and tactical units of our Air Force are stationed abroad, and our Navy makes a major contribution with the Sixth Fleet in the Mediterranean and the Seventh Fleet in the Far East.

These forces must be ready for any mission, from continental land warfare to jungle and desert operations, and for such special tasks as amphibious or airborne operations. Further, they must be prepared to participate in warfare of any scale, from small limited wars to general nuclear war. Their task in general nuclear war would be especially vital since they would be required, at the very outset of such a war, to hold critical areas overseas in the face of enemy attack. During this early phase of a general nuclear war our forces and allied forces might well be outnumbered. This is all the more reason for us to deploy forces overseas which are strong enough to withstand the enemy onslaught until they can be reenforced. . . .

We are now expanding our United States Special Forces—both in the United States and overseas. This will enable a substantial increase in the numbers of allied indigenous forces that are trained to combat these less traditional—but highly effective—forms of conflict. Correspondingly, critically important training of these forces in such fields as counterintelligence and civil affairs can be stepped up. This training is essential to complete success in unconventional operations. . . .

Much remains to be done to develop the kind of military posture our country needs to meet our responsibilities to the free world in the trying years ahead. In a dynamic world, we must continually reappraise the strategy and the forces required to meet the full span of the threat. I assure you that the Defense team is doing its utmost to ensure that this country develops the needed strength.—*Before the Combined Civic Clubs, Columbia, S. C.*

Air Force Safety

GEN. THOMAS D. WHITE
Chief of Staff, United States Air Force

TODAY, safety is a business in the Air Force. It is an integral part of our weapons systems practically from the first line on the drawing board, and flying safety experts are deeply involved in all stages of the development, production, and testing—as well as in the operational employment.

Moreover, our safety programs have, of necessity, expanded beyond the limited definition of flying safety. When atomic energy was introduced into the military forces, the need for a nuclear safety program became immediately apparent. We have had such a program in effect for several years. Now that missiles are with us and our missile force is rapidly growing, we also require an active missile safety program. This also is in being.

Nor is this the end of it—the United States is taking its first short steps into space—with the near-term goal of placing man in the fringes of this environment. And one of the prerequisites of placing man in space is a sure-fire guarantee that we can bring him back alive and well. . . .

The object of all this effort is not just to propel a human being into space—a passive passenger, like Ham, along for the ride. The airman that we place in space must be a thinking, reasoning, useful man—one who is fully operational in his new environment and one who is a major contributing factor in whatever mission he is performing. The X-15 and the Dyna-Soar are our initial efforts to place a man at speeds and altitudes never before achieved. Of equal importance, they are our first attempts to place him in this medium with the ability to control his actions—in truth, to be master of his destiny.

We certainly don't expect our job in the future to be easy. The history of our efforts in the past indicates that safety problems mount in proportion to the complexity of equipment. On the other hand, bold new ideas, imagination, and open-mindedness will be at a premium—as they are right now. We must not allow ourselves to be handcuffed by tradition. The progressive approach always has been an airman's approach. Aeronautics and astronautics are closely allied sciences, and we have not touched the infinite number of possibilities which exist in either of these areas.

New and challenging horizons of achievement are ahead of us—there for the taking providing we reach out for them and put them to work for us. It is to this end that the Air Force is dedicating its full energy and effort.—*Before the Order of Daedalians, Kelly Air Force Base, Tex.*

Industry and Defense

LIEUT. GEN. ARTHUR G. TRUDEAU
Chief of Army Research and Development

WHAT more can industry do to advance development programs in the military area? Here is my 2-word answer: *investigate* and *act*. In so far as our mutual interests are specifically concerned—these are the keys to productive Army-Industry partnership.

1. *Investigate.*—Army Research and Development has just published a significant tool for the use of America's leaders in science and technology—the R&D Problems Guide—a presentation in eight volumes of the problems which currently perplex us and on which we need and invite your help.

Scientific and technological progress generally is asserted to be ahead of military thinking, but such is really not the case. In our Army R&D Problems Guide we have outlined more than a thousand areas in which we are seeking breakthroughs on new weapons systems, matériel, and devices. Solutions to these problems would greatly strengthen our military posture and bring revolutionary versions in concepts of the ground battle. . . .

2. *Act.*—If we are going to save this Nation and the world in the great struggle of our time—freedom against slavery, order against chaos—then we are going to have to conserve both time and money. We must have action—faster, more economical action—in the Military-Industry partnership.

It is now taking too long from the concept of an idea until a piece of equipment is placed in the hands of the most self-reliant man in the world—the American fighting man. As one authority aptly said, "there is a frightful interval between seed and timber." (*Contd. on p. 132*)

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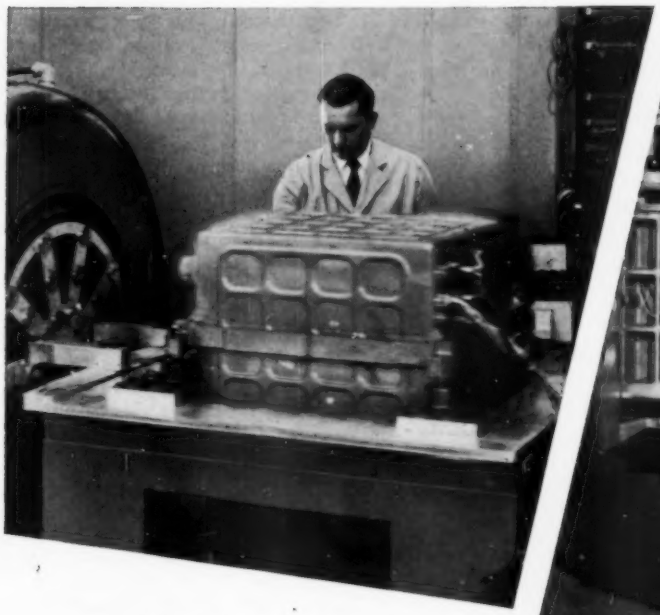

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Arma's chief contribution to our national defense effort is the ability to deliver reliable systems—on schedule and within the budget. All research and development, engineering and production are based on that philosophy. Arma, a division of American Bosch Arma Corporation, Garden City, New York.

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From the Record (Contd.)

Lead-time is a key factor in meeting the Communist threat. Our present weapon lead-time is too long—it is running on the average of seven to eight years. This means that if we achieve a technological break-through today, it will be 1967 or later before our new weapons systems will be in production.

Meanwhile, if the Communists can steal the secret even a full two years after we have it (or have it handed to them for that matter), they can still beat us to the punch.

We must whip this lead-time problem—too much depends upon it—and I believe we can whip it through more rapid, complete, and secure exchanges of information between the Army and industry at every stage of development.

We must continue to adopt new procedures to expedite developments such as, to overlapping and telescoping phases of the R&D cycle, conducting user and engineering testing concurrently or on a combined basis, and starting production engineering and tooling as early in the development cycle as possible.

Longer lead time invariably leads to increased cost. We all must do better in this regard. Present costs are excessive. . . . At times, I think we literally are pricing ourselves out of the ability to defend ourselves.

What this man's Army is looking for in missiles, vehicles, and other equipment can generally be covered by the concept—*cheap, simple, effective,* and *reliable.* We are in the Volkswagen not the Rolls-Royce class. We want a good design, initially. We want function, not frills. . . .

If private enterprise is to continue to flourish in this country—and it won't be the America we love if it doesn't—then, and I mean precisely what I say, then private enterprise engaged in defense industries must exercise stronger management, greater initiative, and a more Spartan approach. Let's tighten our belts and get back to a comfort—if not a necessity—basis, instead of indulging in luxuries we can't afford.

It seems that only a courageous and far-sighted company nowadays thinks it can afford to investigate and act in terms of what is best for our country first instead of what is obviously and simply best only for itself! I am thankful there are some! I wish there were many more! . . . . If this great Nation is to triumph over Communism, retain the American way of life, achieve new heights of progress, advance science and technology, and lead the underdeveloped peoples of the world toward a brighter future, then we Americans—individual and corporate—must place the public interest above self-interest every time. We must burnish bright the shield of American character. Unless we scour it ourselves, it will be scourged by others. —*At dedication ceremonies, Philco Research Laboratories, Blue Bell, Pa.*

Ships of the Future

REAR ADM. RALPH K. JAMES
Chief, Bureau of Ships,
United States Navy

OUR ships have increased tremendously in capability over the years, but the requirements placed upon them also have managed to keep ahead. One such requirement is the increased speed necessary to provide our surface ships a tactical advantage over the modern high-speed submarine. We find, however, that the conventional ship is limited by a natural barrier, the wave-making resistance which must be overcome when ships are driven at higher speeds.

A possible answer to this problem is the hydrofoil concept where we reduce resistance by lifting the hull clear of the surface of the water, providing support through struts which are attached to hydrofoils or wings riding just below the surface.

In addition to the speed advantage, the hydrofoil craft is capable of navigating quite comfortably areas where waves or swells would cause a conventional ship of comparable displacement to slow. Furthermore, the hydrofoil craft may, if desirable, operate for extended periods on the surface as a conventional ship.

Based upon a research program extending back over some twelve years and the rather impressive performance of a 5-ton test craft, SEA LEGS, the Navy included in the fiscal year 1960 shipbuilding program a submarine chaser hydrofoil, PCH. The mission of the PCH will be to conduct antisubmarine patrols in harbors, harbor approaches, and coastal waters. When delivered in late 1962, it will be the first operational military hydrofoil craft designed by and built for the United States Navy.

The PCH will be 117 feet in length, displace 110 tons, and attain speeds of over 40 knots. Height above the surface of the water will be measured by a sonic device, and control of the craft will be provided by an electronic autopilot. This system offers the advantage of higher speeds in the more severe weather and is relatively insensitive to the direction of encounter of the seas.

We currently are evaluating proposals from industry to design and build a 250- to 300-ton hydrofoil research ship, AGEH, which, in the initial version, will be capable of speeds of 40 or 50 knots. At a future date we expect to convert this craft for operation in the supercavitating speed regime, 80 to 90 knots. The AGEH will demonstrate the open-ocean capability of large hydrofoil craft at both moderate and high speeds, and it will, along with PCH, provide essential information relative to military applications of the hydrofoil concept.

We are not satisfied, however, that these two craft will provide the ultimate in capability and have under way in the Bureau of Ships an extensive research and development program in the following areas:

1. The phenomena of supercavitation which could permit hydrofoil speeds of 80-90 knots. In this area, the Bureau is evaluating proposals from industry for the design and construction of a 15-ton supercavitating test craft.

2. The refinement of design techniques and criteria and a search for the most suitable materials.

3. Investigations which will permit us to design and build ships larger than AGEH.

4. The application of the hydrofoil in a military role.

In addition to the hydrofoil program the Bureau of Ships is actively pursuing a program to exploit the air-cushion vehicle or ground-effect-machine concept. We call such craft "hydroskimmers" because they will actually skim or float over the water on a cushion of air. The hydroskimmer never touches the ground or the water except when at rest and in this way avoids the friction of the water.

There are several basic types of hydroskimmers. The simplest of these to describe and understand is the plenum type. Picture if you will an inverted flowerpot. Now attach a simple air hose to the hole in the base of the pot. Turn the air on and the pot will float above the ground or table. The height at which it floats is a function of the amount of air flow. Now add some form of propulsion to this flowerpot, either in the form of an air propeller or a turbojet, and you have a very rudimentary hydroskimmer.

This craft is inherently capable of very high speed (about 100 knots) and from a military standpoint offers several attractive features. It has a large load-carrying capability when compared with helicopters and has great flexibility of operations as a result of its ability to operate just above the surface. The hydroskimmer looks promising in applications such as landing craft, high-speed patrol boats, and mine-countermeasures craft. Finally, in larger sizes it offers potential in the ASW field.

As with hydrofoils, we have initiated a research program which has resulted in the construction of several test craft varying in weight from 2,000 to 4,500 pounds. Beyond this we have asked industry for proposals on a hydroskimmer of about twenty tons and expect to award a contract for design and construction in the fall. Ultimately we will want to build vehicles displacing several hundred tons as a part of a shipbuilding program and be-

yond that we are thinking in terms of displacements of several thousands of tons. . . .

Our studies have led us from above the surface of the waves to the ocean floor and all intermediate levels. They have resulted in designs of landing craft, for example, employing the hydroskimmer principle, which would debark from a mother ship and finally land troops and equipment well upon or behind the beach. They have resulted in novel types of antisubmarine ships, some of which have had drafts as much as 160 feet in order to get a sonar transducer down deep into the ocean.

We have come up with submersible types, including a submersible aircraft carrier whose protection would be afforded by the ability to disappear beneath the surface. We have even been able to design amphibious types which, although capable of beaching like an LST, could also make their approach to the beach in a submerged condition.

Significant advances have been made in the design of submarines during the past few years. Both the fleet antisubmarine-warfare type and the fleet ballistic missile submarine of today reflect the value of our experience with nuclear power in NAUTILUS and with the revolutionary hull form of ALBACORE.

The THRESHER class is designed primarily to destroy enemy submarines but also will be extremely effective against surface ships. The bow of this submarine is especially configured for optimum performance of the long-range sonar which it houses.

Another indication of the future submarine will be provided by the AGSS or experimental deep-diving submarine which was included in the 1961 shipbuilding program. This small vehicle which resulted from our investigations into deep-depth design, will lead toward the ultimate development of larger, deep-diving, combatant submarines.—*Before the Navy League of the United States, Washington, D. C.*

The Nuclear-Propelled Spacecraft

HAROLD B. FINGER
Manager, AEC-NASA Nuclear Propulsion Office, and Assistant Director for Nuclear Applications, NASA

OUR nuclear rocket program is being conducted with the requirements of planetary missions in mind. I am convinced that our program will provide us with the nuclear rocket technology for planetary missions and that, with sufficient support, it will almost automatically provide us with a capability to perform the lunar landing mission and with the technology required to provide for extensive manned lunar operations such as will be required, in time, when bases have been established on the moon.

We believe that we are ahead of the Russians in the development of nuclear propulsion systems and we therefore believe that we can beat them in the long-range space program. . . .

By comparison with chemically propelled spacecraft, a nuclear rocket spacecraft would weigh 900,000 to 1,000,000 pounds—one-tenth the size of the chemical vehicle. It would probably have 3 stages propelled by engines having nuclear reactor thermal powers in the range from 1,000 to 8,000 megawatts. It would still have to be assembled in the earth orbit. Two to four launch vehicles or launch freighters would be required to place in orbit all the material, equipment, propellant, etc., that would be required for assembling the spacecraft.

It is important to recognize that the launch freighters could be the vehicles that would perform the manned lunar landing mission. In addition, the reactor powers required for the planetary trip are in a range that could be used in vehicles for lunar landing operations. The technology required for planetary missions would provide much of the equipment required for the performance of extensive lunar operations.

It is generally agreed that the performance of planetary manned missions will require the use of nuclear-energy systems. From a practical point of view, chemical systems could not do that job. Even if they could, you may be interested in knowing that analyses have indicated that the cost saving of the nuclear rocket over the chemical rocket system, including the development costs, appear to be so great that the nuclear rocket would pay for itself on its first planetary mission. . . .

We must recognize, however, that success in the nuclear rocket program is not yet assured. We are developing a new and advanced technology, but our work to date has been very encouraging. . . . We have tested three research reactor devices with gaseous hydrogen as a propellant and water as the pressure-shell and nozzle coolant. These tests provided us with necessary information on our design techniques and with an improved understanding of materials operating at conditions similar to those that will be encountered in nuclear rocket systems. This Kiwi-A series of tests was remarkably successful, particularly for a point so early in the development of a new system. The Kiwi-B series of reactor tests to be initiated later this year will incude tests with liquid hydrogen as a propellant and as a coolant of all critical parts. . . .

Our long-term lead in space, therefore, requires that we treat the nuclear program with a strong sense of urgency and that we support it accordingly. I am confident that we can develop the systems that we will need for such planetary missions. We must ensure that we retain our lead in this area. —*At ARS-Oak Ridge National Laboratory Meeting, Gatlinburg, Tenn.*

Power by Nuclear Fusion

DR. GLENN T. SEABORG
Chairman, U. S. Atomic Energy Commission

OUR controlled thermonuclear research effort concerns the diversified program to determine the feasibility of producing power through the use of the energy of nuclear fusion.

For those who may not have followed this field closely, the investigators' first problem is to heat a mixture of ions, such as deuterium and tritium, to a temperature sufficient to initiate nuclear reactions between the colliding ions. In a 50-50 mixture of deuterium and tritium, this is about 5 kilovolts, or, in popular terms, about 50 million degrees centigrade. At this temperature, deuterium and tritium nuclei will collide frequently, and many of them will react with the resultant liberation of substantial amounts of nuclear energy.

The second problem is to confine the hot ionic gas—the plasma—long enough to release sufficient energy to be useful in the generation of electricity. Ingeniously devised magnetic fields forming a kind of magnetic "bottle" are used to confine the plasma.

Methods for igniting and confining the thermonuclear plasma are under study at four Commission laboratories—Los Alamos, Livermore, Oak Ridge, and Princeton—and also at the Naval Research Laboratory.

The Soviets have about an equal effort under way. The rest of the world, taken together, accounts for a program about the same size as our own. All are making progress, but many years probably lie ahead before fusion power reactors can be built.

At both Los Alamos and the NRL installations, powerful new condenser banks are being used for rapid compression of plasma in devices of the type called Scylla. Average ion energies of above 2 kilovolts, or temperatures of about 20 million degrees centigrade, have been obtained. . . .

If and when any of these experiments results in confining the plasma satisfactorily, it will be an event of great scientific importance. The production of a well-confined thermonuclear plasma would open the way to conduct other experiments to test the feasibility of a thermonuclear reactor.—*Before the American Physical Society, Washington, D. C.*

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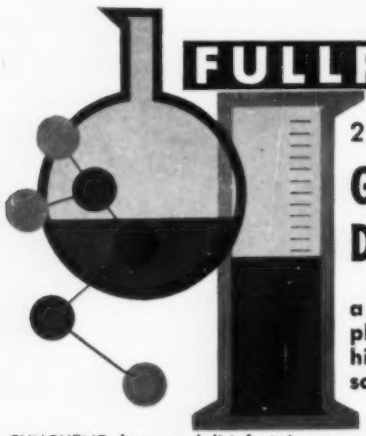

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Book REVIEWS

Reviews in this issue by:

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LEO A. CODD, *editor, Washington, D. C.*

DR. JAMES B. EDSON, *senior assistant for missiles and space, Office, Assistant Chief of Staff, Army Intelligence, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

The Ordnance Department: Procurement and Supply. One of the series on the United States Army in World War II. By: Harry C. Thomson and Lida Mayo. Washington: U. S. Government Printing Office. 504 pp. $4.

AT long last, this eagerly awaited book is here. So many members of the Ordnance Association took part in the events described that their curiosity was reaching the breaking point. Not that they cared especially about the appraisal of their particular efforts; rather their concern was that the gigantic job that was done over-all be fairly and objectively described. For it was a gigantic achievement, the lessons of which are now sure guideposts for future study.

This reviewer believes that Dr. Thomson and Mrs. Mayo have done a very creditable and satisfactory piece of work. It was by no means easy. They are objective in their attitude, thorough in their research, and fair in their appraisals. More could not have been expected.

That the volume was so long in making its appearance was not of their doing nor, all said and done, does it much matter. The record is there, and all who had a part in making it—whether that part was great or small—have their own satisfactions or complaints which already have mellowed with time.

Naturally, each participant-reader will wish that more facts and more emphasis were placed in the text on some particular operation with which he was intimately connected. There is one such incident which I will describe a little later.

In general, these are some of the major highlights. The authors stress the importance of definite and sane military requirements. They stress the essential value of the Army Ordnance district system. They describe the vital steps that were taken in the 1930's in procurement planning. They are very kind in accrediting some of the success achieved in this area to the Ordnance Association. They describe the brave stand of Lieut. Gen. Levin H. Campbell, Jr., the then Chief of Ordnance, who saved the Ordnance Department from extinction. He led the Ordnance Department with outstanding success from 1942 to the end of World War II. The factual record is set forth in his book, "The Industry-Ordnance Team" (1946).

The authors also show that egregious mistakes were made. Our Government in those days—the War Department included—pretty well allowed the British to compute our military requirements. As a result we were far, far overproduced in many

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costly items. Similarly, the authors describe what amounted to hysteria on the part of American and British higher-ups in doubling our ordnance production programs; *e.g.*, small arms ammunition, tanks, and other items.

All in all, this book has inestimable value for the lessons to be learned, what to do and what not to do. I wish there were more evidences today that those lessons were taken seriously enough—not by those who have the Ordnance responsibility without the authority but by those who have the authority but not the responsibility. The over-all record of the Industry-Ordnance Team in World War II is nothing short of phenomenal.

The phase I have saved for the end is the authors' treatment of the background years prior to the ordnance research and production build-up of 1939. I mean the 20-year period 1919-1939 when the Army Ordnance Department was molded into an alert, talented, devoted, and extremely competent organization of military and civilian experts. To them must be given a vast share of the credit for the quality and the quantity of the national weapons output when Pearl Harbor ignited the fuze for our participation.

Never has there been a more proficient, industrious, and dedicated group. They were professionals of the highest order who knew what they were about and did what they knew must be done fearlessly and promptly. They were expert in war planning, leaders in research and engineering, outstanding in management, industrial cooperation, and supply.

Two outstanding leaders in preparatory planning of those days were Maj. Gen. James H. Burns (then Colonel) and Maj. Gen. C. T. Harris, Jr. (then Colonel). Their pioneering and prudent planning brought industry and the military into close and realistic liaison.

And the result? When war came the Ordnance-Industry Team was so far ahead of most other members of the national-defense organization that its major programs were far advanced and actually under way before many in authority knew the full implications.

This was the key to the success that followed. I hope I will not be misunderstood when I say that I wish this phase could have been dwelt upon in this book at greater length. But then, another volume would have been required, and I am sure the powers would not stand for that. This much must be said: The competence and *esprit* of the Industry-Ordnance Team were due to men of great vision and stern judgment. Their names should be written large on the scrolls of those to whom the Nation is indebted.

I shall not attempt to name them here nor tell of their individual loyalties and contributions. Rather, let two names symbolize all that I have tried to indicate. They are: Maj. Gen. William Crozier who was Chief of Ordnance from 1901 to 1918 and his successor, Maj. Gen. C. C. Williams, who led the Ordnance Department from 1918 to 1930. These giants set the pace, and they inspired the team and equipped it, in ability and *esprit*, to be ready for the task when the Second World War came. Their inspiration was not in vain, and our country is all the better for it.—Leo A. Codd.

Organizing for Defense—The American Military Establishment in the Twentieth Century. By Paul Y. Hammond. Princeton: Princeton University Press. 403 pp. $7.95.

DESPITE all that has been written concerning General Staff planning, it would be difficult to find any book which gives a clearer historical background picture of the General Staff than this one written by an outsider—a political-science professor who has specialized in the managerial problems of national defense.

Weapons of war have changed drastically, but leadership problems have not changed since Julius Caesar said: "Victory depends more on the ability to alter plans than on any excellence of the plans devised"; or since Gen. Anthony Wayne said: "I never saw a council (of war) that was more than the talk of old women"; or since more recent days when General Grant said: "My book of strategy has only four words—'When in doubt, fight!'"

Wars on a worldwide scale have made centralized staff planning an absolute necessity, but centralized staff planning has inherent dangers—ironing down to mediocrity by trying to please all factions, prolixity in trying to formulate solutions for all eventualities, and rigid authority that paralyzes field commanders.

But the greatest danger of all lies in the hedges, the "ifs" and the "provided thats" which come from the civilian controls exercised in a democracy but not found in the armies of autocratic states.

We modeled a General Staff after the German example, but it is not possible in a democracy to use the original German method of strict discipline and direct action. The author quotes one of our eminent chiefs of war plans as saying: "The State Department, not the War Department, is the policy-making agency."

The author himself says: "What indeed constitutes control? When is a Congressman, a civilian executive, or the constitutional Commander in Chief himself, in control of the armed forces? . . . Finding answers is a discouraging prospect indeed."

The author does not provide the answers, but he does give in the book a comprehensive analysis of the problems involved. Americans inherently fear military dictatorship, and civilian control is a necessity in a democracy, but civilian "interference" in times of emergency can be disastrous. The over-all problem is to find a workable balance.

The book is well worth study for its analysis of one of democracy's major problems.—George S. Brady.

Mississippi in the Confederacy. Vol. I, As They Saw It. Edited by John K. Bettersworth. Vol. II, As Seen in Retrospect. Edited by James W. Silver. Baton Rouge: Louisiana State University Press. 362 and 319 pp., respectively. $5.95 each; $10 the set.

THESE two volumes are published for the Mississippi Department of Archives and History and consist almost entirely of letters, diaries, addresses, and the like, describing the minutiæ as well as the consensus of the experiences and thoughts of the Mississippi people during and after the Civil War. Some quite interesting contrast is offered by the two collections —"As They Saw It" and "As Seen in Retrospect."

The editors' text is rather brief, but such devices as lengthy quotations from contemporary newspapers and later books add to the "connective tissue" of the work. It still falls short of being a chronological history, yet offers a great deal of interesting personal documentation.

It is certain that the value of the work would have been greatly increased had a short subject index been provided. It is definitely not for the reader whose interest in the Civil War is casual nor, probably, for one whose information is scanty. But to the reader who is conversant with the military history of the conflict, the social background here offered may prove of real worth.—F. W. Foster Gleason.

The Nation's Safety and Arms Control. By Arthur T. Hadley. New York: Viking Press. 160 pp. $3.

THIS book explains very well some of the thinking now controlling our national security and our moves toward disarmament. While all of us, particularly those who have devoted their lives to national security, deplore the facts presented on our highly vulnerable position, we must deplore even more the highly unfavorable, unsatisfactory choices that appear to remain, if we are to have any continued national existence. The following quotations from the book help to point up the problem:

"In today's military situation two facts produce the hyperinsecurity that makes

He solved this puzzle by taking it apart!

Like oil and water, extreme precision and "complete" mobility resist combination in tracking radar antennas. Designing for one of these characteristics "automatically" precludes the other. *That* was this AMF Engineer's puzzle—to put *both* precision *and* mobility in an antenna for duty with the Marine Corps.

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Among the design innovations that solved the puzzle is a "piggyback" gear arrangement that puts both azimuth and elevation drives in one package. Result: almost half the parts and weight of separate components. Precision fabrication is typified by the reflector arms, held to a .005" deviation over 45 inches!

(For unclassified information on early warning and radar antenna systems, write Dept. CS 1, address below.)

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limitations on arms presently impossible. There is the vulnerability of America's strategic deterrent, principally SAC, to surprise attack . . . and also the reliance on nuclear war to solve practically all our military problems.

"For it is not only the presence of nuclear arms, but the absence of certain other types of forces that contributes to the terror and instability . . . and it is why the arms controller is advocating the build-up of certain types of arms as the first step toward arms limitations.

"The victory of freedom would not be assured with the advent of arms control —the struggle would merely shift to other areas and go on . . . nor would the defeat of freedom automatically result if arms control fails. . . . The problem is to walk the path between surrender or suicide, but there will be those who unwittingly want to rush down one or the other."

For those who have assumed that freedom and virtue would triumph eventually, and before too long, the arguments in this book present a most powerful awakening. For those essentially concerned with national defense and our future, the book leaves many doubts and presents an urgent challenge.

How can we effectively safeguard our country, our people, our resources, and our way of life without provoking nuclear war? How can we give stout courage to those fearful ones who cry, "Better Red than dead"?

Should we let the terror and fear of nuclear war dominate all aspects of our thinking on security? Does this preoccupation with terror and any submission to it on our part reduce in any way the Communist threat—the nuclear threat to our existence? To some of us, long devoted to national security, such appeasement can have only the usual catastrophic results.

If the Communists want peace and stability, they can have it on any reasonable terms. But it should be abundantly clear that the Communists do not want peace and stability. They want to dominate the world, and, more than that, they want to crush the United States. As long as this aim prevails, negotiations toward stability in any area will be unrewarding and probably dangerous.

We must have the courage and the stamina to continue the contest until their aims are altered. What we require is firmness, strong belief in our country, unity of purpose, and the determination to make the necessary effort.

This book shows we are in real trouble. It also shows that the way out is hard and difficult.—EDWARD P. MECHLING.

Science in Space. Edited by L. V. Berkner and Hugh Odishaw. New York: McGraw-Hill Book Company. 458 pp. $7.

UP out of the sun come huge explosive storms to stir our orbiting instruments and to shake from our outer atmosphere the glowing streamers of the polar lights. In the far reaches of our planetary system, a crumpled turbulence of magnetic force diffuses the cosmic radiations of the sun, and of the stars. How are stars born from the nebulae? How long do they burn? How do they die?

Cannoneer, were the atoms of your steel tube forged in the thermonuclear heart of some ancient, alien sun, now dead these ten billion years? Did the carbon of your powder (and of your own body) once float in the atmosphere of a strange "smoky star"? And are the molecular patterns of your life substance the same as those that we may soon find on Mars?

"Science in Space" is a superb comprehensive review of our current knowledge on these and many other topics. It is organized around the uses of space vehicles for basic research. In this volume we see our National Academy of Sciences at its best in the service of our professional community and of all thinking people.

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Book Reviews

The two editors and the twenty authors are senior members of the Academy's Space Science Board. They intend the book as an invitation for all trained minds to join in the great pioneering space research just now beginning.—JAMES B. EDSON.

Airborne Radar. By D. Povejsil, R. Raven and P. Waterman. Edited by G. Merrill. New York: D. Van Nostrand Company. 823 pp. $17.50.

IN these times, technical know-how is the key to power. Like other scarce resources it should be stockpiled for ready access in time of need.

Captain Grayson Merrill, as editor of the series, "Principles of Guided Missile Design," has contributed notably to this national stockpiling of technical knowledge in ready form. In "Airborne Radar" the authors and Captain Grayson have produced an excellent new addition to the series. Compact but lucid, it leads the reader through all the main steps necessary to the design of the airborne radar subsystem of a major weapons system.

The book will be easy and useful reading for any graduate of a sound course in electrical or electronic engineering. It is the kind of a volume that the young engineer will want and use. And, my older colleagues, if you feel the need of a bit of a retread to bring you into the line of current thinking, this one may be for you!—JAMES B. EDSON.

BOOKS RECEIVED

Atomic Energy Waste—Its Nature, Use and Disposal. Edited by E. Glueckauf. New York: Interscience Publishers, Inc.; London: Butterworth Publications, Ltd. 420 pp. $14.

Dynamics of Rigid Bodies. By William Duncan MacMillan. New York: Dover Publications, Inc. 478 pp. $2.

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Electronic Technology Series—Vol. 36, Filters and Attenuators. 96 pp. $2.25. **Vol. 37, Transformers.** 88 pp. $2. New York: John F. Rider, Inc.

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Foreign Aid, Our Tragic Experiment. By Thomas S. Loeber. New York: W. W. Norton & Company. 139 pp. $3.50.

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Management Guide for Maintenance Cost Reduction—Vol. 7, Industrial Management Series. By Bernard T. Lewis and William W. Pearson. New York: John F. Rider Publisher, Inc. 80 pp. $1.50.

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Special Studies—Military Relations between the United States and Canada, 1939-1945. By Col. Stanley W. Dziuban. Washington: U. S. Government Printing Office. 432 pp. $5.

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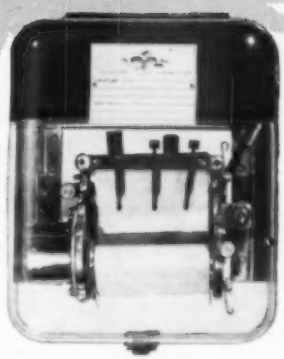

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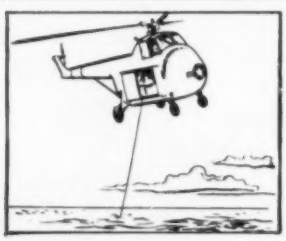

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Armament Technology

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Minuteman Vehicle Design

Missile range, cost, and reliability govern the selection of materials

D. L. Baker

Aero-Space Division, Boeing Airplane Company, Seattle, Wash.

THE Minuteman weapon system, although rapidly becoming operational, is in the research and development test period at this date. Consequently, the structural concepts noted herein may be revised. The scope of this discussion is limited to components designed primarily for the boost phase of the trajectory which include the skirt, engines, interstages, and instrumentation and guidance-and-control sections.

The assembly and test contractor (Boeing Airplane Company) is responsible for boost-phase loads, vibration, acoustics, and weight integration of the entire missile in addition to the design and production of skirts, interstages, and the instrumentation section. These aspects of the structural design will be emphasized in this paper.

The Minuteman is a 3-stage, solid-propellant intercontinental ballistic missile with a mission to destroy strategic targets. The missile will be launched from underground tubes and railroad trains providing random mobility. A diagram identifying the major missile components is shown in Figure 1.

To obtain maximum range, the Minuteman missile is designed for flight loads only, which are defined as all loads existing after lift-off, including the launch-tube environment during engine ignition. As a consequence, it is required that ground handling equipment, such as highway transporters, mobile trains, and launch stands, be designed to impose no loads on the missile greater than flight loads. To accomplish this, ground system equipment springs, dampers, and missile-attachment points must be optimized.

The flight load factor of safety and the heating factor of safety are 1.25 and 1.0 respectively. In addition, it is required that no detrimental structural yielding occur at limit load.

THE ground handling equipment load factor of safety is 1.5. This factor is greater than the flight factor to provide adequate safety for ground crews and to provide adequate structural fatigue life.

The design trajectory selected results in the most severe aerodynamic heating and greatest dynamic air pressures obtainable during the attack mission. These conditions would exist during an attack mission on a hot day combined with maximum engine performance and a low-altitude guidance trajectory.

All operational missile structures will be substantiated and evaluated by test firings. Test missile structures will differ from operational structures only by the addition of an instrumentation section which adds eighteen inches to the length of the test missiles. To use identical metal gages, all components are designed for the greater of operational and research and development missile loads. The range penalty is negligible.

CONTENTS

ARMAMENT TECHNOLOGY SECTION

Minuteman Vehicle Design .. 141
D. L. Baker
Materials play an important part

Take-off, Vertical! 144
Loren E. Bollinger
Success of the X-13 Vertijet

New Antitank Weapon 147
Robert E. Sebring
The lightweight M72 system

Solid-Propellant Rockets 150
J. L. McDaniel
Weight must be reduced

Antisubmarine Warfare 153
Rear Adm. H. L. Miller
More research is needed

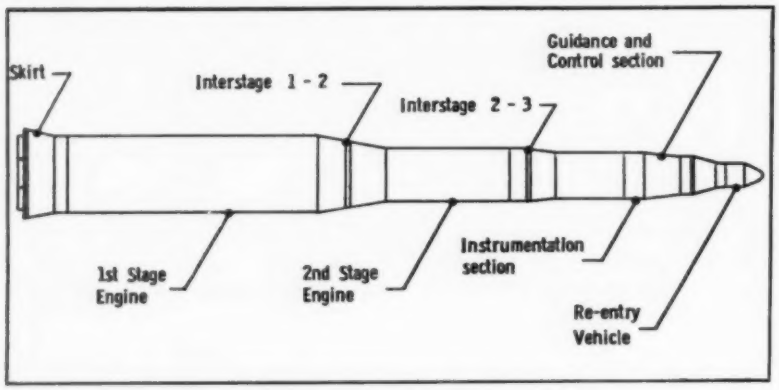


Fig. 1. Missile components of the 3-stage, solid-propellant Minuteman.

Due to starting-squib ignition and rapid build-up of thrust at launch, a tension-compression shock load travels up the missile. Simultaneously, the missile is loaded with an external pressure wave plus a sonic environment resulting from exhaust-gas discharge. This set of conditions results in a design condition of axial internal loads together with 20 p.s.i. (gage) limit external pressure and 170 db limit noise level at the skirt, decreasing to 160 db limit at the guidance section.

WHEN the missile reaches an altitude of approximately 300 feet, a turn is executed requiring full nozzle vectoring which establishes a critical design condition for the aft end of the first-stage engine.

Design wind velocity and wind shear load criteria are based on a statistical approach which assures that the weapon system will accomplish its mission during adverse weather conditions. To determine angle of attack and nozzle response, wind velocity versus altitude, guidance and control equations, missile velocity, aerodynamic coefficients, and structural dynamic characteristics were programmed into a computer. The resulting solution of angle of attack and nozzle position versus altitude together with wind-tunnel test data were used to predict loads.

Interstage limit internal pressures at 1-2 and 2-3 staging are 75 p.s.i. (gage) and 50 p.s.i. (gage), respectively. Interstage 1-2 and 2-3 acoustics during staging are 180 db limit. Stage 2 and Stage 3 maximum nozzle vertoring occurs during staging.

To minimize coupling of the control system with the structural modes and to minimize dynamic load magnification, the minimum natural bending frequency of the missile is 5.1 c.p.s. Equipment mount frequency ranges are maintained above 50 c.p.s. to avoid dynamic magnification of the engine ignition transient first mode missile response.

During exit from the launch tube, the missile is immersed in engine exhaust gas. Maximum heating rates of approximately 200 Btu./ft.^{2}/sec. exist. After exit, a cooling period exists until, at approximately 12,000-feet altitude, aerodynamic heating commences. Maximum aerodynamic heating rates are approximately thirty Btu./ft.^{2}/sec. During the latter part of second-stage burn, the missile leaves the atmosphere and a cooling phase exists until reentry of the nose cone.

During the boost trajectory, small amounts of engine exhaust gases circulate forward from the exhaust plume to the engine dome and then back along the skirt to exit. In addition, radiant heat from the exhaust gases is absorbed by the base area. A base heat deflector is provided that reduces base heating to approximately twenty Btu./ft.^{2}/sec. on the skirt interior from a no-base heat deflector value of eighty Btu./ft.^{2}/sec.

During staging, direct flame impingement results in short-time heat pulses of approximately 675 Btu./ft.^{2}/sec. on localized areas such as nozzles and interstage structure and equipment.

Relative gain in range using various materials in missile components.

2–3 INTERSTAGE	*% Range Gain*
Aluminum	0
Magnesium	.23
Beryllium	.78

Thermal insulation adds considerable cost to the airborne vehicle. An alternate to insulation is metal of sufficient thickness to act as a heat sink, thereby reducing temperature and stress to acceptable limits. Studies of this alternate design showed unacceptable range penalties of approximately 1,000 miles.

Because no other missiles had utilized insulation over the entire exterior surface, a very thorough study and development test program was required for the Minuteman system. The initial studies to evaluate insulations were based on material properties derived from laboratory tests that approximated actual environmental flight conditions.

These studies narrowed the insulation choice to fiberglass, acrylic, cork, inorganic-filled plastic compositions such as Thermolog and Avcoat, and elastomeric materials such as buna N rubber and PR-1910 silicone. In addition, the following were determined:

1. Low ablation temperature materials, such as acrylic, resulted in range performance considerably superior to high ablative temperature materials, such as fiberglass.

2. A spray-on insulation offered simplified processing, particularly for the engines.

FOLLOWING the initial studies, the most promising materials were subjected to further laboratory tests which closely simulated launch-tube and in-flight thermal environment. In addition, laboratory test results were verified by full-scale tethered missile tests in progress at Edwards Air Force Base to optimize launch-tube design. The precise material properties obtained from these tests were used for a final optimization study. It was then concluded that Avcoat (epoxy resin plus polyamide hardener plus trace chemicals), sprayed in place, would be the standard insulation for the Minuteman missile.

The only exceptions to the standard existing today are the aft engine domes, nozzles, the guidance and control sections, and miscellaneous equipment such as wiring. The typical structural temperature and insulation thickness (ablation) versus time curve is shown in Figure 2.

The following are the primary design considerations for the engine cases:

1. Internal pressure during burning is the most critical design load. Even though the solid-propellant mass is of low modulus of elasticity it is sufficiently stiff to stabilize the thin structural walls for nonburning axial compression, bending, and external pressure conditions. Only local details such as skirt to interstage attachment skirts are critical for nonpropulsive conditions.

2. The second-stage engine, being near the center of the first-mode bending shape, has a predominant effect on missile bending natural frequency.

3. To prevent propellant ignition at the outside surface, engine cases are insulated to prevent temperatures in excess of 350 degrees Fahrenheit.

4. Because of the processing difficulties associated with applying heat or pressure to a loaded engine, a spray-on insulation process is greatly superior to a bonded-sheet process.

EXISTING engine design configurations for first- and second-stage engines consist of forged cylindrical sections of heat-treat steel, welded at the joints. Forward and aft end domes also are forged from high-heat-treat steel. The forward domes are welded to the cylindrical section. The aft domes are attached by threads for Stage 1 and by studs for Stage 2.

The third-stage engine is fabricated from filament-wound fiberglass which results in an excellent strength-to-weight ratio. A pound of structural weight saved on the third stage affects range by a factor of approximately 4 compared with the second stage and approximately 16 compared with the first stage.

The major nonpropulsive structural components of the Minuteman airborne vehicle are the first-stage skirt attached to the aft end of the first-stage engine; two interstage structures tying the first-, second-, and third-stage engines together; the instrumentation section; and the guidance and control section.

The skirt serves a threefold purpose. It helps impart aerodynamic stability to the missile during the critical period of first-stage separation, it provides a base for missile support on the launch stand, and it provides a point of longitudinal restraint during missile transport. Studies devoted to exploring possible missile range improvement through changes to the skirt configuration or complete deletion are in progress at the present time.

Both interstage structures provide missile structural continuity and contain the primary elements of an electrical and linear charge stage separation system. In addition, the second to third stage interstage structure contains and supports the primary flight control accelerometers.

The instrumentation section contains the command destruct system, optical and radio tracking devices, and a telemeter data acquisition system used to obtain missile performance and evaluation data. This section is only utilized during research and development flight tests.

The guidance and control section contains an inertially stabilized platform and a digital computer. These components solve the guidance and control equations, generate steering commands, and dispatch staging and thrust termination discretes.

The launch-tube environment, including external pressure, sonic environment and axial starting shock compression, results in the primary critical design loads for the nonpropulsive components. Only local details, such as joint tension capability and equipment, are critical for flight and staging loads. However, structure optimized for the launch environment does not have high margins of safety for wind shear or staging.

Consequently, even though it may be feasible to reduce the severity of the launch environment, only minor reductions of structural weight would result.

The nonpropulsive components, with the exception of the instrumentation section, utilize skin plus circumferential frame construction. This structural arrangement results in a considerable weight saving compared with a simple pure monocoque design.

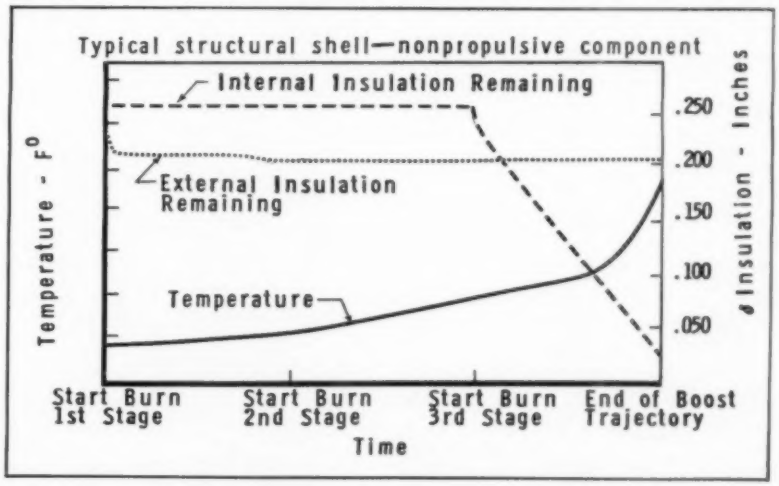
Monocoque construction was selected for the instrumentation section for the following reasons: (1) A stiff (high E.I.) section was required to minimize the difference in natural frequency between test and operational missiles; (2) maximum stiffness-to-weight ratio results from pure monocoque structure.

RANGE, cost, and reliability are the major considerations in the selection of materials. Studies of several materials indicated that beryllium, magnesium, and aluminum alloy are the most promising materials. Beryllium material showed appreciable range gain but was rejected because of the high cost and limited production experience.

Aluminum alloy was selected in preference to magnesium alloy for the following reasons: (1) At contact with the steel engine cases, a potential corrosion problem existed with magnesium during storage in the launch tube; (2) bonding of Avcoat to magnesium is very difficult; (3) the range gain for magnesium was small.

To improve missile range, beryllium and magnesium structures are still being investigated. Recent changes in launch-tube environmental control, together with increased beryllium processing knowledge, may result in the use of magnesium and beryllium for later missiles. (This article was presented as a paper before a recent meeting of the A.O.A. Missiles and Astronautics Division held at Point Mugu, Calif.)

Fig. 2. Curves show structural missile temperature and insulation thickness vs. time.



Take-off, Vertical!

The Ryan X-13 Vertijet aircraft won an exciting race against time and proved the practicability of an airplane that could take off and land straight up and down and fly in the conventional manner

Loren E. Bollinger

Aeronautical engineer and assistant professor, Ohio State University, Columbus, Ohio

IN recent years there has been a number of research-type aircraft built along the vertical take-off and landing concept. The many advantages of a VTOL airplane are fairly obvious. For military use the advantages are particularly important and, in some instances, imperative.

Today's modern jet fighters require a very long runway to take off. In the event of a combat emergency, it is rather unlikely that all the prepared runways of satisfactory length will be available for use.

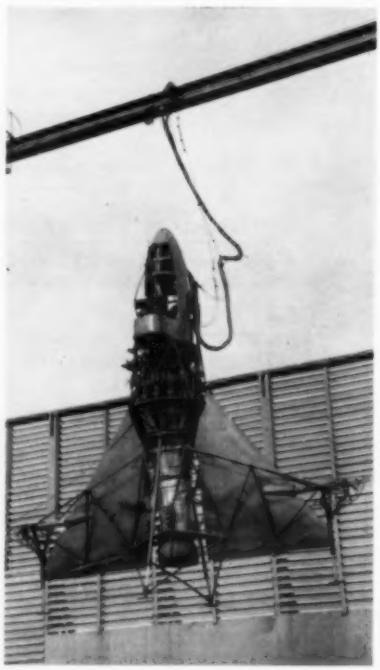
Quite likely a number of military bases will be knocked out within the first few hours of combat, particularly if the war is fought with missiles—either the intercontinental type or the intermediate-range ballistic missiles. For these reasons our military establishment has been sponsoring some effort in VTOL-type aircraft since the late 'forties.

One of the most interesting VTOL aircraft developed during the last decade has been the Ryan Aeronautical Company's X-13 Vertijet plane. At the time that Ryan started work in this field the idea of a VTOL aircraft seemed rather farfetched—something of a dreamy-eyed excursion into the unknown.

A prime operational requirement for any VTOL plane is that the thrust of the engine be greater than the total weight of the airplane. Otherwise, of course, the plane could not rise vertically from the ground.

The idea behind the X-13 experimental craft began with the Ryan FR-1 Fireball which was a combination jet-plus-propeller Navy fighter that was built near the end of World War II. It was this fighter that put Ryan in the jet VTOL business. One engineer noted that the Fireball airplane came very close to doing the impossible, that is, of climbing straight up from the ground.

Ryan X-13 Vertijet undergoing tethered flight test to check its control system.



This plane had almost an equal thrust-to-weight ratio when the fuel tanks were nearly empty. Therefore, they reasoned that with a more potent power plant installed in a plane built along similar lines it would be possible for the craft to take off vertically.

AFTER some calculations on a company-sponsored program, the idea was presented to the U. S. Navy Bureau of Aeronautics which became interested and awarded Ryan a contract to investigate the problems involved in controlling an aircraft at speeds that are near zero when there is little or no airflow across the surfaces of the plane that are normally used for control purposes.

The idea was for Ryan to explore the feasibility of using jet reaction controls for such an aircraft. Instead of using propellers this radically new plane was to use a jet engine, because, as we know, high-performance planes require jet engines to obtain the necessary thrust at near-supersonic or supersonic speeds.

These initial theoretical studies took about a year during which a large number of control arrangements were investigated. Next, a horizontal test stand was built using a modified Allison J-33 turbojet engine.

Results from these ground tests showed that a relatively simple system could be used for control, and in 1950 a system was made ready for tests on the equipment in the vertical attitude. Tests to check the operation of the jet

reaction control system components were made in each plane of rotation by utilizing a free mount.

In October 1950 the test vehicle lifted off the ground under its own power. Motion was obtained in all three planes and the vertical position. Each was controlled remotely by a pilot on the ground.

AFTER the successful conclusion of these tests, the mount was removed and loose tethering cables were installed to permit limited free flight. On May 31, 1951, the world's first free-hovering jet flight was made, though the tethering cables limited the motion of the vertical test system.

The vehicle was raised, hovered, moved horizontally, and landed a sufficient number of times to demonstrate with reasonable thoroughness the practicability of jet-reaction control for hovering and vertical flight.

After conducting further tests with a simulated delta wing, a pilot seat and controls were mounted on top of the vehicle and on November 24, 1953, Pete Girard of Ryan made the world's first piloted hovering jet flight.

Next, a tilting seat was added to compensate for the vertical attitude of the model, and further tests were made in this modified vehicle. The famous military test pilot, Maj. Gen. Albert Boyd also piloted the craft in hovering position during a visit in 1954.

All the preliminary steps now had been taken. The next step was to design and fabricate a research type of VTOL airplane. Various models of possible configurations were made, and wind tunnel tests were then conducted to try them out. Four months later the Navy awarded a supplemental contract for the preliminary design work on the research airplane. However, all work had to be halted when budget revisions greatly reduced the funds that were necessary to complete the program. It was at this point that the Air Force entered the picture.

The Navy agreed to turn over all the work done to date and the Air Force followed through with a contract to build a research plane. This act was the beginning of the X-13 program.

By the fall of 1955 the first Vertijet plane arrived at the Air Force Flight Test Center, Edwards Air Force Base, Calif. A conventional fixed tricycle landing gear was installed and the plane

Before vertical flight, normal horizontal take-off was made with temporary gear.

made a conventional flight on December 10, 1955, with Ryan's test pilot, Pete Girard, at the controls.

Later the tricycle landing gear was removed and a temporary structure consisting of tubing was installed to allow "tail sitting" operations. These were needed in order that the plane could be checked out while hovering near the ground as the mysteries of transition between hovering and conventional flight were being explored.

It was on May 28, 1956, that the first hovering flight was made; later this test was followed by simulated "hook-ons" to a wire stretched between two upright towers. By now another X-13 had been built and delivered to Edwards AFB. This plane was used to explore the transition from medium-speed conventional flight to hovering vertical flight at safe altitudes.

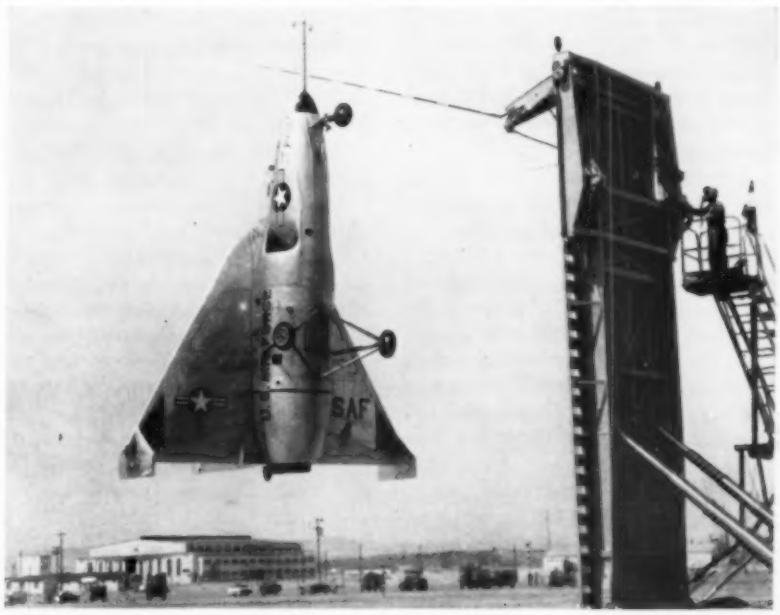
Some of the background before the full cycle of successful VTOL operati took place is rather interesting. O.. of Ryan's vice-presidents returned from Washington with the important news that the tactical systems officer of the Air Research and Development Command would hold a rather important briefing on April 12th concerning the latest thinking on jet VTOL aircraft.

They indicated that it would be very helpful if movies of a demonstration of Ryan's X-13 Vertijet complete flight sequence could be shown. Of course, the plane hadn't gone through this maneuver yet!

One corollary seemed rather clear: If the Vertijet flight were not made by this date and movies shown, a big opportunity probably would be lost.

There seemed to be plenty of time

One man on the trailer aids the Vertijet's pilot practice landing on a cable.



available, as there were many months before the April 12th deadline. Delays, however, kept cropping up. The most infuriating and frustrating thing was that none of the delays were due to bugs in the design of the craft.

By 6 o'clock on the morning of April 11th, just one day before the deadline, the X-13 Vertijet sometimes had spent less than one-half hour a week in the air.

IN one accident, a crane had dropped the plane and repairs took eight days. Next, a hangar fire set them back five weeks. The normal snags in postponement of a flight test program came oftener than usual, or at least it seemed that way. Once there was a fuel leak which was noticed as the plane moved down the runway. This delay cost four days. Sometimes there were as many as three aborts in a single day.

By March 29th the Ryan men still felt sure of beating the deadline. All that remained was to remove the temporary undercarriage and then affix the steel hook permanently in the plane's belly. Some practice was needed in hovering while the hook was on the trapeze cable of the ground-service trailer. Then Pete Girard could take off, fly around once, and hook on again. April 12th was still two weeks away—plenty of time left.

Then came another unforeseen event. That afternoon a trailer accident broke newly installed struts which would hold the plane away from the trailer bed.

Fastening of the new set of struts took until April 8th, although the hangar crew worker a 70-hour week. Time was running out. There were some choice words for the cumbersome ground trailer!

Although they knew well that a smaller and simpler trailer would serve just as satisfactorily and that in actual combat a jet VTOL would not need a trailer at all, the trailer was designed on the conservative side because of the experimental tests.

By the morning of the 9th the plane again was ready for trial. The trailer bed was tilted up on its dump truck and Pete fired up the Vertijet for a final practice. He eased up and down while staying hooked to the cable just to check out everything. In this final practice test, however, Pete found that the plane didn't handle right. The accelerometer had gone haywire.

A new one was put in and tried that afternoon. It didn't work either. The only other accelerometer that would fit into the Vertijet was in the hangar stock room—they hoped! After hours of hunting they found that it wasn't there at all. By 11 o'clock that night, an accelerometer was located in San Diego, and a couple of engineers started on a 200-mile drive to Edwards.

At 4 the next morning mechanics began installing the accelerometer. Late that morning Pete made another test from the cable. The accelerometer still didn't work correctly. The repair of an accelerometer usually takes days.

One man ran across the field to warm up the company Navion to fly back to San Diego and try to repair the accelerometer within 36 hours. However, before he could take off, one of the technicians hollered that they thought one man had an answer for it and that no one had to go to San Diego. One of the electronics technicians had found that the accelerometer was installed at the wrong angle. It could be installed in any of three positions; however, only one was satisfactory.

In order to save time, the accelerometer was repositioned blind. Normally a number of metal tubes and wires would have to be removed in order to make a visual check. However, the accelerometer was positioned and a new trial was scheduled. Then the wind was too strong.

So they came to the finish line.

Before dawn on the last day before the Pentagon meeting, trials were started again. First came a briefing in the operations room—then out to the plane. The cards were about to be dropped. If they fell wrong, the development of the jet VTOL craft might be postponed for years.

AS Girard moved out to the plane he noticed the crew members checking the intricate parts for the last time. The fire trucks were waiting, and the ambulance, and the big crane.

Finally all six stations of the test team had radioed in to report that everything was in readiness.

At 6:55 Pete was in the cockpit and the preliminaries were over. The canopy was closed, and the switch touched which starts the jet whining like a buzz saw.

The yellow trailer began to tilt up like a drawbridge, raising the Vertijet vertical. More and more power was applied to the jet engine and the plane dangled from the cable. The X-13 rose to the top of the cable's limit as controls were given a final check.

There it stood. The plane, standing on its tail of gas, bellowed and strained upward. Then the hook was released and for the first time the Vertijet was clear of the cable. It moved sideways almost like a ballerina. Then it arched up and over like a diver coming off the springboard. It was in horizontal flight shrinking into the horizon.

The troubles were not all over—the trailer developed trouble and the trapeze arm fouled.

THEN the plane howled out of nowhere and streaked low over the photographers and again vanished into the distant horizon.

The trapeze arm on the trailer still wouldn't work. Without this arm it would not be possible to land the X-13 satisfactorily. Finally it was decided to move in trailer number two.

By now the Vertijet was back over the field coming in for a landing. It tilted slowly toward the sky and its airspeed dropped until it seemed certain to stall. Finally, all forward motion was stopped. The X-13's tail hung down vertically.

It almost appeared that the law of gravity had been defied. Then the plane backed toward the ground and the massive blowtorch in its tailpipe blew up cyclones of dust as it moved across the field walking upright almost like a man.

The Vertijet kept coming slow and steady and sure toward the reserve trailer. Finally it moved into position with its steel hook poised a foot above the cable.

The man in the crow's-nest beside the cable on the trailer pressed the button to the trapeze arm and the cable caught the hook. Pete cut the throttle and the jet unwound like a tired siren.

The historic flight was over, and the films were shipped to Washington.

Since that time many successful flights of the X-13 have been made. Two planes were built in this program—one is now touring as a ground exhibit; the other one is headed for a museum.

During its hectic but interesting course, the Ryan-Air Force X-13 program had provided our country with a wealth of experience in vertical flight.

New Antitank Weapon

Robert E. Sebring

THE U. S. Army Ordnance Corps has recently developed the M72 rocket—a light antitank weapon. The addition of this weapon is another big step in reequipping our Army with a new generation of modern armament.

The M72 provides a lethal punch in a surprisingly lightweight package. Tactical mission for the weapon is the defeat of enemy armor by individual infantrymen. The complete weapon system consists of a rocket-propelled high-explosive antitank (HEAT) round and a disposable carrying case and launcher combination. Weight of the complete system is only 4½ pounds

A shaped-charge warhead is contained in the round, which is propelled by a fin-stabilized rocket motor. Burning time of the rocket is of short duration, so that burnout occurs while the projectile is still within the launcher tube, and the gunner is not exposed to blast or rocket exhaust.

There is virtually no recoil, and persons who have fired the weapon agree that reaction felt by the gunner is less than that produced by a light-gauge shotgun. The most vivid sensations are a visual awareness of the flight of the round and its impact on target, and the noise of the propellant charge which is comparable to that of company-level infantry weapons.

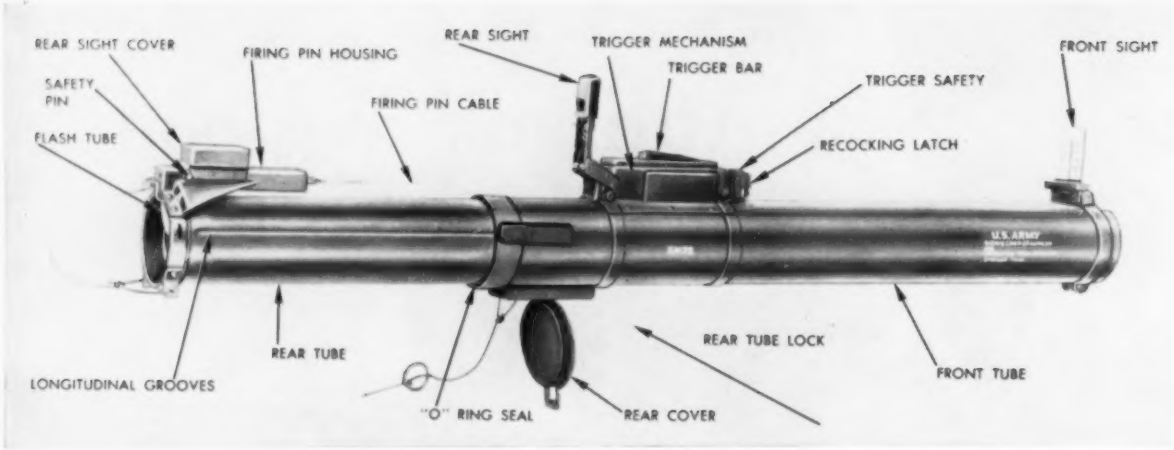
Mr. Sebring is chief of the special test and evaluation equipment branch, Hesse-Eastern Division, Flightex Fabrics Inc., Everett, Mass.

In the closed position the launcher is two feet long; it is fitted with an integral, adjustable, canvas web sling, and makes a compact, easily worn or carried package. The weapon is instantly readied for firing by removing the sling and the launcher end caps and then extending the telescoping launcher tube. The extended launcher and large-field open sights allow a comfortable positioning of the weapon on the shoulder so that it can be aimed and fired rapidly from any of the conventional shoulder-weapon firing positions.

Prime contractor for the M72 system is Hesse-Eastern Division of Flightex Fabrics, Inc., which completed development work under contract with Army Ordnance Missile Command, Redstone Arsenal, Ala. The real beginning of the program preceded this development contract by several years. It started at a U. S. Army Infantry firepower demonstration at Fort Devens, Mass., which was jointly sponsored by the Army and by the Yankee Post of the American Ordnance Association.

SUCH a demonstration includes a mass firing of many types of weapons and subjects the viewer to a crescendo of noise and to an oppressive awareness of the destructive firepower available to Army combat units.

Two of the weapons included in this demonstration were the rifle grenade and the 3.5-inch rocket, and two of the spectators at the demonstration were Charles B. Weeks, general manager of Hesse-Eastern Division, and Paul V. Choate, now engineering manager of Hesse-Eastern. These men were impressed by the possibilities for improvement in the performance of both these weapons, and conceived the idea that a new weapon which combined the best features and functions of each could also overcome many of their inherent shortcomings.



Disposable carrying case and launcher for the new M72 antitank weapon.

This idea became the LAW (light antitank weapon) concept, which promised a weapon system with the light weight and one-man operation of the rifle grenade, but with a flatter trajectory and far better accuracy. It also afforded range, accuracy, and destructive power comparable to the 3.5-inch rocket but in the form of a one-man weapon with only a small fraction of the 3.5's weight and bulk.

To these was added another idea—the use of an inexpensive, expendable combined carrying case and single-shot launcher. This would drastically reduce weight, simplify the transport and supply of ammunition, and eliminate problems in loading the weapon under combat conditions.

THESE basic principles were amplified and further developed into a proposed new weapon system which was submitted for consideration by the U. S. Army Infantry Board and the Office of the Chief of Army Ordnance. The Army recognized that the LAW would fill an immediate and pressing military requirement, and as a result the development contract was awarded on February 24, 1958, by the Army Rocket and Guided Missile Agency, Redstone Arsenal, through the Boston Ordnance District.

Steady and rapid progress of development under this contract was achieved. One reason for this was the closely cooperating Army-Industry Team which was signed on to do the job. This was headed by a top-level triumvirate consisting of the user agency, the Infantry Board, the development agency, and the development contractor. Below this tier and assigned to specific problem areas relating to their particular technological specialties were a number of additional Army installations and industrial subcontractors.

Included in the Army team were: Redstone, Picatinny, Frankford, and Radford Arsenals; Aberdeen Proving Ground; Redstone Division, Rohm & Haas Company; the Infantry School; the Diamond Ordnance Fuze Laboratory; and the Lone Star Ordnance Plant. Included in the industry team were: Bridgeport Brass Company, Zenith Radio Corporation, Eastern Tool & Manufacturing Company, Lamtex Industries, Inc., Harvey Aluminum Company, Sprague Electric Company, and American Optical Company. Important contributions to the program were made by these organizations, and the success of the project was due in part to the participation of these and other groups not listed here.

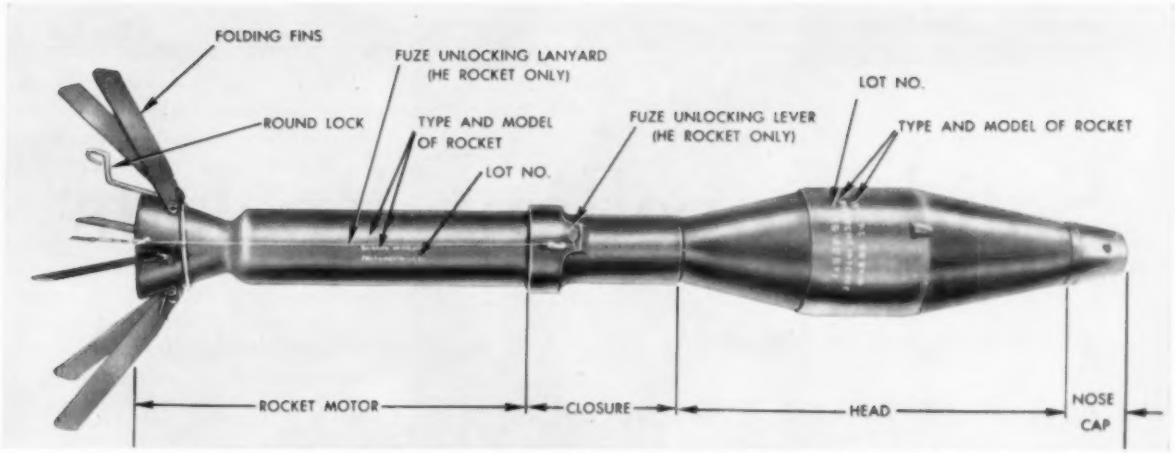
It is almost axiomatic that the development of a totally new or significantly improved military system is dependent on the recognition and application of technical innovations in components of the system. These can include the utilization of new materials and new manufacturing methods or designs. The LAW system has been realized by the profitable use of many such innovations, or "firsts." Some of these are important enough to be a large part of the story of the weapon. Among these are the following examples:

First use of a low-pressure rocket motor in a shoulder-fired weapon. This allowed the use of lighter-weight metal motor parts designed to accept the lessened loads resulting from the reduced operating pressure. It also made possible a longer, slimmer rocket motor, with attendant advantages of better weight distribution and a near optimum fineness ratio of the round body. These benefits were obtained without compromising velocity or total impulse and while maintaining a short enough burning time so that an in-launcher burnout would occur before the round had traveled a distance less than its own length.

Another first is the use of an aluminum-alloy motor in a shoulder-fired rocket. This choice of material provided benefits through both improved performance of the product and manufacturing economies in its production. Key to this happy combination was the utilization of the impact-extrusion process for manufacturing the motors. The extruded motors require only a minimum of machining to finish shape, and the complete motor and nozzle section is made in one piece.

A new assembly process for metal parts of the HEAT warhead was initiated in the program. This simplified process eliminated soldered or brazed joints and substituted a shrink-fit, mechanically locked joint which eliminates distortion and produces truer, tighter-tolerance warheads at a considerable saving in production cost.

ALL the technical advances were not limited to the rocket projectile since many interesting features also are evident in the design of the M72 rocket launcher. First of these is the unique telescoping tubular launcher which in the closed position has a dimensional envelope not much greater than the round which it contains. This of course means a minimum of bulk and weight to be carried by the burdened infantryman. Indeed, this small size and light weight of the system package in contrast with its high performance and lethality is its most commented-on feature.



A fin-stabilized rocket motor and shaped-charge warhead make the M72 projectile lethal against heavy armor.

The launcher outer tube is fabricated from aligned-fiberglass-wound reenforced plastic, and results in a lightweight thin-walled tube with unexcelled corrosion resistance, resiliency, and strength-to-weight ratio. No adverse effect on the launcher tube is produced by firing the rocket motor, and although the launcher is simply designed in keeping with an intended single-shot usage, it actually is capable of functioning for scores of repetitive firings. This capability has been demonstrated in test firings during the development program.

The LAW system is one of the first rocket weapons employing a packing-case launcher to reach the readiness-for-production stage. Several other weapons may employ this idea, and it probably will become a widely used feature for several classes of weapons.

THE expendable-launcher concept required a sighting system which would enhance the inherent high accuracy of the weapon without a prohibitively high cost. This requirement eliminated the consideration of an optical sighting system, and spurred the development of a simple but effective open sight. This has taken the form of a rear peep sight, with the aperture position adjustable for temperature compensation, and a plastic reticle front sight with engraved range-scale cross lines.

Results of this were highly successful in that the cost was not objectionably high, and added benefits were provided in the form of quicker target acquisition, wider field of vision, and usefulness under greater extremes of lighting conditions. The accuracy and ease of operation of this system has been borne out in demonstrations where previously untrained gunners have obtained well-placed direct hits with their first firing of the weapon.

A reasonably high velocity and consequent flat trajectory is developed by the rocket, and performance variation attributable to changes in ambient temperature have been held to a low level, with adequate built-in provisions for temperature compensation.

Another design feature of the weapon is the use of a percussion-initiated system for igniting the rocket motor. With no dependence on an electrical system powered by a magneto or battery, there has been a hold-down on system cost and an increased reliability not obtained with electrical components. Problems of susceptibility to corrosion and short shelf life, which would have been a particular stumbling block with a battery system, have been side-stepped. The ignition train is fast and efficient in that total delay time intervening between squeezing the trigger and the start of acceleration of the rocket is only a few milliseconds.

Physical proportions of the round, including caliber and stand-off distance of the HEAT warhead and length and diameter of the rocket motor, are combined in an over-all round shape with good aerodynamic properties. Aerodynamic configurations of the fins and of the whole round shape provide a ballistic coefficient more nearly ideal than can usually be associated with projectiles of this general type.

An orderly progression of the development contract required that a series of test programs be instituted and conducted concurrently with the engineering design effort. An indication of the alacrity shown in this program is the fact that the first test rocket vehicle was designed, loaded, and fired within two months of the signing of the contract. Another indication of saved time was the pursuance of a continuous review program of production engineering and value analysis which was carried out in phase with the research and development engineering—and with only a slight time lag behind the R&D engineering effort.

ALL these concurrent programs were carried out by the system prime contractor. This technique was made workable because responsibility for the entire system was placed with the one contractor and not divided among separate agencies with separate responsibilities for ammunition, launcher, sighting system, etc. This procedure has resulted in a drastic compression of the usual development time period, and as a result the weapon successfully passed engineering and user tests within only two years and eleven months from initiation of the original contract.

Its effectiveness is further testified by the relative ease with which the weapon met and exceeded the requirements of many of the tests.

In this modestly scaled program, the directed team approach provided a timely and economic solution to many problems. With several agencies simultaneously attacking a problem there are afforded more chances for a breakthrough from multiple pressures or an alternate advance around the problem.

In pursuing these expansive programs, it is necessary that the full strength of an Ordnance-Industry Team be mustered. All available technical strength is necessary for the required rate of progress and for the most effective attainment of the objectives.

Solid-Propellant Rockets

The problem is to reduce the weight of all elements other than the payload which must be accelerated to final velocity while at the same time improving simplicity, ruggedness, and final reliability

J. L. McDaniel

LARGE solid-propellant rockets were born to meet the requirements for a missile system capable of instant deployment from a highly mobile division or field army as well as instant retaliatory action from a fixed installation. These requirements imply extreme simplicity, ruggedness, and reliability along with maximum performance.

The materials problems of solid rockets must be defined within the framework of the opposing requirements for simplicity and performance. In striving for simplicity, the solutions of the problems of materials for rocket motors were for a time hampered by the philosophy that the rocket motor was a simple pressure vessel and could be designed and treated as such.

THE simple pressure vessel is, however, complicated by the forward closure bulkhead which sometimes contains ports to afford the thrust termination or cancelation required to effect separation of the stages or for impulse control. The simple pressure vessel is further complicated by the nozzle and its associated components. Thrust vectoring is required to control the direction and attitude of the missile. One of the proven methods to provide thrust vector control is the use of jet vanes. The nozzle, the jet vanes, and reversal ports are subjected to the severe environment of the motor exhaust products. This requirement presents a materials problem of some magnitude.

Mr. McDaniel is technical director, Research and Development Operations, Army Ballistic Missile Agency, Redstone Arsenal, Ala.

The requirements for increased performance and reliability became everyday conversation in all walks of life with the advent of the IRBM, the ICBM, and particularly the satellite. The term "payload" came to be recognized as that part of the rocket which was placed on the target or put into orbit and did not include those elements of the system such as the motor case, nozzle, and guidance parts.

However, the total system must be considered in determining the weight of the payload delivered. Even if the payload's weight were reduced to zero, acceleration would still have to be applied to all other elements if the missile is to "fly."

The major materials problem facing us today is one of reducing the weight of those elements, other than the payload, that must be accelerated to final velocity, while at the same time assuring simplicity, ruggedness, and reliability for the missile.

The over-all performance or final velocity can be improved by increasing the energy delivered by the propellant (specific impulse) or by reducing the weight of the inner parts; that is, increasing the ratio of the propellant weight to the total weight:

$$V_f = gIsp\ In\ \frac{Mt}{Mi}$$

Where: V_f is the final velocity, Isp is the specific impulse, Mt is the total mass, and Mi is the inert mass. For the propulsion system the total mass is equal to the sum of the propellant mass and the inert mass: $M_t = M_p + M_i$. Also for a given propellant grain design and motor case, an increase in propellant density will increase the final velocity.

A VARIETY of examples has been used to show the relationship between inert weight and useful weight for a propulsion system. One of these examples is the use of the ratio of propellant weight to the total weight for some familiar items.

A can of beer is approximtely 81 per cent propellant and the remainder of it is inert parts. An egg is quite a bit better with approximately 90 per cent of useful content and the balance inert shell. A packaged loaf of bread has about 98 per cent usable weight.

Significant strides have been made in missiles in the last decade in increasing the ratio of propellant weight to total weight. The mass ratio of the German V-2 rocket was on the order of 0.66 while the mass ratio of a cur-

rent typical motor is on the order of 0.90. This increased mass ratio has resulted in more than a twofold increase of theoretical final missile velocity.

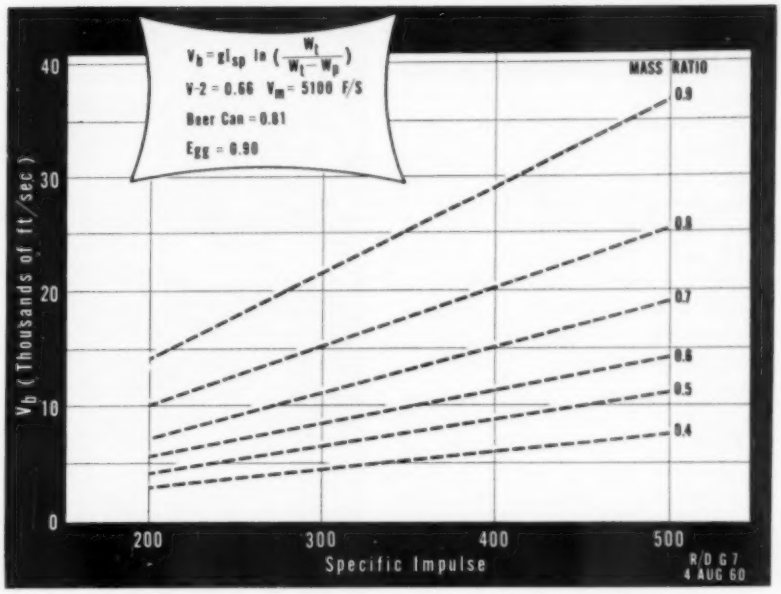
The weight breakdown of the inert parts for a typical motor for a ballistic missile is tabulated below showing per cent of total motor weight: Case, 3.0; liner, 0.5; insulation, 1.0; sliver, 2.0; nozzle, 3.0; ignition, 0.05; impulse control, 0.1; thrust vector control, 0.5. Total inert weight is 9.15 per cent and the motor mass ratio is 90.85 per cent.

In the materials field, two approaches are being used to increase the ratio of propellant weight to total weight. The first of these is basic research in metallurgy and the second is engineering to compromise major inadequacies. Significant break-throughs have not yet occurred in the basic research efforts; however, these efforts must be emphasized since they eventually will yield the most dramatic results. The engineering approach in the meantime has had important successes.

Among the many problems to be solved by the basic research approach, one of the most fundamental is the question relating to the brittle behavior of high-strength materials. The requirement for high strength-to-density-ratio materials for motor cases has resulted in the investigation of high-strength materials such as titanium, stainless steels, and alloy steels.

A comparison of 4130 steel, H-11 steel, and titanium for the Army's Pershing ballistic missile shows the advantages to be gained from the use of a high strength-to-density-ratio material. Recent investigations have indicated, however, that the reliable use of the high strength-to-weight-ratio materials may be limited by their notch sensitivity. Thus the attainment of reduced weight by increased strength is opposed by a decrease in material toughness.

Research also must yield solutions to lightweight materials to stand up under the exhaust gases.



Vehicle velocity for various mass ratios and specific impulse.

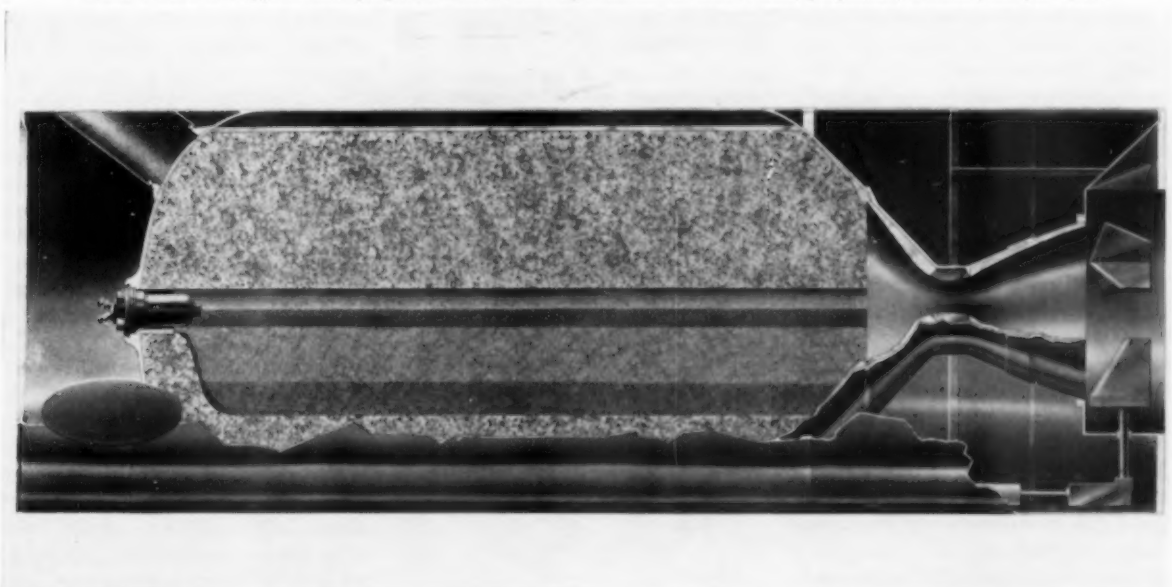
The energy of the propellant is related to the combustion temperature by the expression:

$$Isp = \sqrt{\frac{T}{M}}$$

Where Isp is the specific impulse, T is the temperature of combustion products, and M is the molecular weight of combustion products.

Thus it is evident that a high-energy propellant and its resulting flame temperature precipitates an immediate requirement for engineering materials to

Cross-section of a typical solid-propellant motor showing head-end thrust reversal, propellant, actuator, and jet vane.



withstand this increased flame temperature.

Combustion temperatures of rockets of today are on the order of 5,500 degrees Fahrenheit. However, materials must be found in the future to withstand temperatures up to 8,500 degrees Fahrenheit. These materials are required for nozzles and thrust vector control devices which must withstand the abrasive action of the combustion products as well as the elevated temperatures.

PROBABLY the most significant engineering advancement or compromise approach in the area of propellant weight to total weight, or weight fraction, came about with the development of the technique of bonding the propellant to the motor case. This technique was introduced by the Jet Propulsion Laboratory under Army sponsorship shortly after World War II. The Army has continued to advance the state of the art in case-bondable propellant in the Government-owned Thiokol Corporation-operated facility at Redstone Arsenal, Ala.

Shown at right is a cross section of a case-bonded solid-propellant motor. The propellant burns from the inside toward the case in a uniform manner. The propellant, being integral with the insulation material which bonds it to the case, protects the motor wall from the heat of the combustion products, thereby allowing the wall thickness of the motor case to be reduced.

Prior to the development of the technique of bonding the composite propellant to the motor case, early double-base propellants were cast in "charges" or grains and inserted in the rocket chamber. The mass fraction of a motor using the old-type inserted grain is understandably less than for a motor using the cast-in-place grain.

The search for an engineering solution to the problem of materials for use as jet vanes has resulted in the testing of a wide variety of metals and combinations of metals.

The results of jet vanes exposed to a 5,500-degree-Fahrenheit rocket exhaust for 38 seconds are pictured above. The 85 per cent tungsten 15 per cent molybdenum material (top, above) withstood this environment without appreciable deformation.

The stress system in the solid-propellant rocket motor under a dynamic environment must be carefully analyzed in order to fabricate lightweight systems with the necessary reliability. Rapid strides have been made in this field, but a variety of problems remain. These problems are more acute in the dome end which contains reversal ports and at the connection between the cylinder and dome ends.

Above, results of various-alloy jet vanes exposed to 5,500° F. rocket exhaust for 38 seconds. Below, cross-section of solid-propellant motor. Lines at bottom indicate successive surface configurations as burning progresses.

When the motor is fired, an expansion of the casing results. The distortion of the casing and head generally occurs in such a manner that geometrical similarity is not retained. The resulting stress couples may result in deformation at the junction of the cylinder and dome end.

The design of a system to account for this stress pattern would appear to be a fairly straightforward engineering problem. The problem is, however, not so straightforward when the materials are of a brittle nature and contain flaws of one kind or another.

The flaws may themselves determine the stress pattern in their vicinity and will then determine the failure characteristics. Design parameters and fabrication techniques must be brought up-to-date to cope with the use of high strength-to-weight ratio materials in modern rocket vehicles.

The materials problems of the case-bonded propellants used with the high strength-to-weight ratio motor casings also are significant. Since the coefficient of thermal expansion of propellants is about ten times that of case metals, the case-bonded grain must have a high ultimate elongation throughout the temperature range of application.

IN summary, then, we should return to the problem that faces us. The task is to reduce the weight of those elements other than the payload that must be accelerated to final velocity, while at the same time obtaining the required simplicity, ruggedness, and reliability. This problem is common to the missile systems of all the services.

A common reservoir of basic knowledge can therefore be established, conserving funds and manpower. Much progress on a problem can thus be made through supporting research along with critical component development, and the solutions applied, with necessary refinements, to specific missile and rocket systems.

Antisubmarine Warfare

We now have the weapons, ships, aircraft, and detection devices capable of finding and destroying snorkel-equipped, diesel-powered submersibles, but much more research and development are needed

Rear Adm. H. L. Miller

IT is obvious that the strength of the free world lies in its ability to use the sea lanes for trade and commerce with friends and allies. In fact, over 99 per cent of all materials are carried by the 18,000 merchant ships of the free world. These sea lanes are the bonds that permit the combined strength of the independent nations to stand in integrated opposition to the Communists.

The free world's security—even existence—depends heavily on bringing together vast but widely scattered resources to form effective integrated strength. Most of this "hook-up" must be done via the sea routes, for the free world consists not alone of wholly free and independent peoples but also of vital physical assets and natural resources.

These assets and resources are scattered literally all over the face of the globe—of some seventy-seven strategic raw materials we are self-sufficient in only eleven.

BUT the seas are also important to us as a base to protect our military power. The first task of United States defense forces is to deter general war—to deter nuclear attacks against the United States and the free world. To do this we require a retaliatory force capable of inflicting unacceptable destruction on the enemy—even though he may strike first. One of these deterrents is the Polaris submarine, the newest addition to our national arsenal of weapons.

Admiral Miller is Commander, Carrier Division 15, U. S. Pacific Fleet, San Diego, Calif. This article is taken from Admiral Miller's address before the Naval Armament Seminar held during the Forty-third Annual Meeting of the American Ordnance Association in Los Angeles, Calif.

However, we also have our attack carrier striking forces plus other naval forces which play a vital role in deterrence.

Should the deterrent fail and a nuclear exchange occur, we must be able to continue to fight—and to prevail. This means that we must be able to put troops ashore in other untouched areas of the world when those nations which are being threatened by the Communists request help. If we do not, a third power will arise and assume world leadership. This undoubtedly will be a Communist country, and we will have a Communist world, if the forces that we need to secure untouched areas of the world are not on ships cruising the seven seas in areas close to the remaining Communist masses.

With a substantial portion of our troops on ships we will be able to protect the free world and commence the huge task of reconstruction.

But we also must use the seas as a base for our military forces for other types of war—crises, shows of force, shooting wars. We must be able to apply measured force in the degree required, and we must fight if international Communism is not to succeed.

Soon virtually no spot on earth will be beyond the range of attack from the sea, and an even greater proportion of our deterrent and retaliatory forces will have to be based there. In the immediate future the importance of these seas will be even greater. The vulnerability and magnetic effect of our fixed-base weapons will force a more rapid shift to mobile and sea-based concepts.

We must, then, use the seas of the world. To use them we must be able to control them, and in time of war we must deny their use to the enemy.

TODAY we face a very serious threat to our use of the seas. We are faced with a danger hidden in the depths of the oceans—a force of more than four hundred Communist submarines.

To understand this threat better, let us briefly review the development of the submarine itself, for we have faced it before.

Military men had been trying to make a fighting tool of underwater craft since Alexander the Great put sailors in glass barrels to attack enemy ships. But nobody took the submarine very seriously until World War I—when a tiny U-boat rewrote the naval doctrines of the world on a single afternoon and created a problem that is still with us.

Crude by today's standards, this soli-

tary German submarine shattered three British cruisers in rapid succession and sent them to the bottom of the sea.

In spite of the fact that the Kaiser's U-boats were unable to stay submerged very long—because they had to come up to breathe and recharge their batteries—they did fantastic damage until the Allies developed the skill to find them and the sea power to stop them.

By the time they were brought under control, those elusive German submarines had parlayed their 3-cruiser start into 4,837 Allied ships sunk, grossing almost 10 million tons.

Looking back, we realize just how crude was our method for detecting submerged U-boats. The hydrophone of World War I, a sort of overgrown stethoscope, gave us our only detection clue—the telltale noise of the submerged submarine. Fortunately for us, those early submarines were very noisy!

Those hectic days also saw the development of depth charges as our Navy's primary weapon of attack on submerged submarines. This weapon had been invented by Thomas Edison in Key West in 1915.

Again, it was fortunate for us that World War I U-boat construction was such that our depth charges didn't have to explode very close to be fatal.

Between World Wars I and II, submarines grew bigger, stronger, faster, and could stay submerged longer. And, during this period, their primary offensive weapon—the torpedo—gained in speed, power, and accuracy.

Despite these technological improvements, submarines were still limited in underwater endurance by the electrical reserve in their storage batteries. Recharging those batteries took many hours on the surface—a period when there was always the danger of being detected.

WHILE submarines were growing up, our Navy was developing the art and science of antisubmarine warfare which was beginning to be well known by its abbreviation, ASW. ASW was built around a new technique for underwater sound navigation and ranging, which soon was reduced to another abbreviation by which it is far better known today—sonar.

In action, sonar works by bouncing underwater sound waves off a submerged submarine and determining its location by measuring the time interval and direction of the returning echo.

With the development of long-range patrol planes, such as the famous PBM Mariner, antisubmarine warfare became three-dimensional. Airplanes and blimps teamed up with ships, covering vast ocean areas, forcing submarines underwater by day, cutting their time for recharging those vital storage batteries to the hours of darkness.

And then, with another major technological break-through—we developed a technique for piercing that final protective blanket of night by using radar—an abbreviation for radio detecting and ranging equipment.

WORLD War II began with a gruesome and expensive lesson in the importance of adequate antisubmarine forces and techniques. Hitler started out with fifty-seven U-boats and kept up a frantic building program throughout the war. When control of the seas was finally in Allied hands, 996 Axis submarines had been destroyed—but, once again, the Allies lost almost 5,000 ships—this time totaling 21 million tons.

At first, the score was completely lopsided in favor of enemy submarines, but, as our ASW improved, the score began to even up. Here's how the fighting went.

In early 1942, the Allies were losing thirteen ships for every enemy submarine we managed to destroy. A year later the ratio had been reduced to two ships lost for each submarine sunk. And by 1944 we were making Hitler pay two submarines and two full crews for every Allied ship he managed to sink.

To gain this ratio in 1944 it was necessary to increase our forces so that our ASW ships equaled 2½ times the number of enemy submarines, and our ASW aircraft numbered 6 times the number of submarines.

It took time to produce these results. We may not have so much time in the future.

In winning the mighty battle against Hitler's submarines for control of the seas, teams of destroyers and aircraft protected convoys of Allied ships—ships which carried men and equipment needed to win the land and the air battle and vital materials needed to manufacture the weapons of war.

Land-based patrol planes and blimps searched millions of square miles to attack submarines on their way to and from their hunting grounds.

The famed American hunter-killer team—a small aircraft carrier with its attack planes and destroyers—finally broke the back of the submarine by leaving him no part of the ocean where he could operate without fear of combined surface and air attack.

Toward the end of World War II, Germany developed the long-range snorkeling submarine.

The snorkel tube could be raised above the surface from a submerged submarine to provide air for operation of the diesel engines. The exposed portion of the snorkel tube—about as big as a wastebasket—permitted the submarine to recharge batteries while submerged—and thus was far more difficult to detect.

The Soviets captured many of these, new and intact, after the surrender of Germany, and used German captives to help them build their massive submarine fleet which represents their only hope of contesting American seapower.

There are now over 400 Communist submarines; Hitler started with only 57. How will they use them?

THEY could use them to cut us off from our allies—and isolate us just like any island in the ocean.

They could use them as missile launchers against the United States. Every city, factory, or military airfield in the United States would be vulnerable to attack when the range of an enemy's submarine missile is increased to 1,200 nautical miles.

They could use them against merchant shipping. Everyday, more than 2,000 major merchant ships are traveling the North Atlantic. Over 5,000 more roam other seas, while 12,000 other ships stand in port, loading or discharging cargo.

Slicing through these lifelines would soon isolate us from our allies, close down the factories that enable our communities to work and live, and prevent us from projecting our military power to help our allies in resisting Communist aggression. The role of sea power is clear: we must protect these sea lanes for our own use and for the peace and security of the free world.

Now let's look at the environment of this formidable weapon, the submarine. Once the submarine has slipped beneath

the bright, sunlit surface of the ocean, it is in a world of darkness. Light penetrates only a few hundred feet, and radar will not function at all.

To the surfacebound hunter, the ocean presents its unbroken pattern of waves and wind streaks, without a clue to the presence of the enemy below. This is the battleground of the submarine.

THE problem is to find the submarine without using human eyes while the submarine is operating in the mysterious deeps of the oceans. The nuclear-powered submarines have given us great freedom of movement throughout these oceans. The advent of these true submersibles has reemphasized how little we know about the vast hidden world beneath the seas.

We know that shrouded in the darkness of the oceans lie mountain ranges whose peaks rival Mount Everest in height—trenches whose dark depths plunge seven miles beneath the surface. We also know of subsurface currents —virtually rivers in the depths of the sea—twelve hundred times greater in size than the Mississippi.

The general undersea topography is already well established. It falls into three widely different geographical areas. The continental shelf, the continental slope, and the floor of the sea.

There is much that we do not know about the oceans, and this is one of our greatest problems in ASW. How do we go about hunting submarines there?

To date we have depended upon the use of sound techniques. But sound has its drawbacks. Sonar detection ranges are relatively limited, and echoes are returned by whales, schools of fish, masses of seaweed, and rock formations, as well as by submarines. It is very difficult to tell what is reflecting the sound pulse when the sonarman hears an echo.

Furthermore, a sound pulse traveling through the water may be deflected by an area of changing water density. These areas are caused by changes in the temperature or salinity of the water, and are found throughout the oceans. A marked change in water density may divert the sound pulse in such a manner that a submarine very close to the hunter will not be touched by it at all.

The submarine itself may make enough noise to be heard by sensitive microphones at great distances. Theoretically, it would be possible to design a listening system that would detect the slightest sound of a submarine. But the dark world beneath the surface is not a silent world. It is actually a liquid jungle, with its inhabitants making enough noise to drown out all but the noisiest subs.

The use of sound in hunting submarines has its problems, but the sonarman and his well-trained ear remains our best means of locating an underwater target, deciding whether or not it is a submarine, and zeroing in for the attack.

That is the problem posed by the environment of the submarine—to locate him and destroy him in the depths of the sea.

How do we intend to counter this threat? There is no simple solution, and ASW requires a flexible strategy.

Antisubmarine warfare starts on the enemy shores, not our own. We would attack the submarine in its own back yard. We would make rocket and missile strikes against shipyards and submarine pens from our attack carrier striking forces. These forces would also hunt out and destroy the enemy's floating sub bases and tenders.

We also must attempt to destroy enemy submarines before they get to sea. We will attack them as they depart for the open ocean, concentrate our ASW forces to protect our vital surface forces, and continue the attack on the remaining submarines as they try to go back home.

OUR new killer submarines would seek out the aggressor in the depths of the sea—off his home ports and bases and in narrow passages. Minefields would be laid by aircraft, surface ships, and submarines to block the enemy's front doorsteps to the seas. Finally, we would attack and destroy the enemy submarines at their target—in their launch areas if they are missile submarines, or near our ships if their target is shipping. What do we have in ships, planes, and weapons to back up this strategy?

Nearly all naval ships contribute in

Typical of the newest type atomic submarine is the PATRICK HENRY, shown just getting under way (General Dynamics photo).

one way or another to ASW. As already indicated, the attack carrier striking force, built around the attack carrier, contributes by its ability to strike bases.

So, too, do Polaris submarines, the most inevitable retaliatory weapon in the world today.

Shore-based patrol aircraft and seaplanes are another vital tool of ASW. They are capable of patrolling and searching large areas. Their radars, electronic detection equipment, sonobuoys, and other equipment give them the capability not only to detect but to localize and destroy enemy submarines.

Our Navy has a wealth of experience in operating submarines as antisubmarine forces. Our own submarines can operate in enemy waters or in transit areas or can team up with patrol aircraft or hunter-killer forces to detect, track, and destroy submarines.

> *"The problem is to find the submarine without using human eyes while the submarine is operating in the mysterious depths of the ocean. The nuclear-powered submarines have given us great freedom of movement throughout these oceans. The advent of these true submersibles has reemphasized how little we know about the vast hidden world beneath the seas.*
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A HUNTER-KILLER force is a specialized group made up of ASW carriers, aircraft, helicopters, destroyers, and submarines. This group is capable of operating in the open oceans as well as in close support of other forces.

The ASW carrier is the mobile, high-speed command center which doubles as a portable airfield and logistic base. Safe from shore-based ballistic missiles, it acts as a home for its highly maneuverable ASW aircraft and helicopters. With its under-way replenishment support, the hunter-killer group has great mobility and endurance.

Surfaced or snorkeling submarines can be detected by the searching eyes of airborne or shipboard radar of the force. Submerged submarines are detected with sonar equipment aboard our ships and attack submarines, by listening devices, called sonobuoys, dropped from ASW aircraft, and by sonar equipment lowered by hovering helicopters.

What weapons do we have in ASW? Besides the rockets, depth charges, and torpedoes of World War II, we have a number of new and highly effective weapons for destroying submarines.

The Navy's new atomic depth charge, Lulu, has been tested and is now operational. The effectiveness of Lulu makes the biggest of our World War II depth charges seem like a Fourth of July firecracker.

The antisubmarine rocket called Asroc can carry either a depth charge or a homing torpedo as its warhead. This weapon, launched from surface ships, makes it possible to attack submerged submarines at extended ranges after being detected by long-range sonar.

The Subroc antisubmarine rocket is launched by our submarines while submerged. Our submarines with their sonar listening devices can detect enemy submersibles at very long ranges and attack quickly by launching a Subroc.

Radio-controlled helicopters from destroyers at sea will greatly extend the destructive range of today's ships and take advantage of new, long-range sonar. The robot helicopter will become more and more important in destroying nuclear-powered submarines. When nuclear subs replace the diesel-powered ones, we will need detection devices and weapons of more advanced design.

Antisubmarine warfare is a true team effort when units are combined into a hunter-killer group. For example, the limitations of one vehicle are more than compensated for by the capabilities of another.

Through coordination, careful timing, controlled action, and proper tactics a hunter-killer group commander is able to apply this team effectiveness to great advantage. The sum of the capabilities of the team is far greater than the sum of the individual abilities of the various units—be they destroyers, tracker aircraft, helicopters, or ASW carrier.

But the basis for this team is *man*—the naval officer, the sailor—his ability, dedication, and determination.

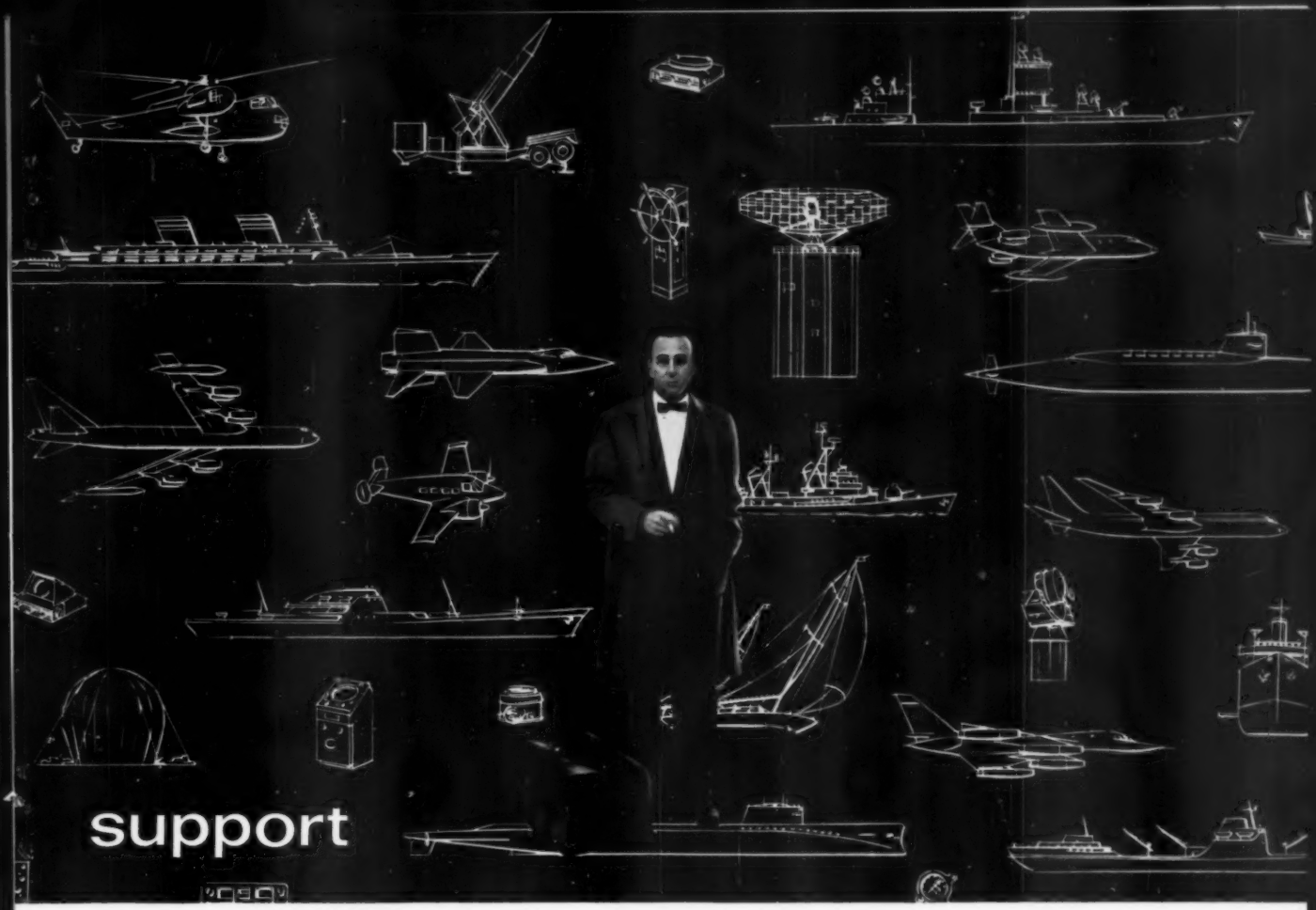
WE can draw certain conclusions from our experience in ASW to date: Weapons and equipment to cope with the snorkel submarine exist. However, all our ships do not yet have this modern and effective equipment, but time and money can do much to close the gap.

Secondly, we need more effective measures and equipment to fight the nuclear submarine. We need help in finding out better answers to the following: (1) *Detection*—we need new techniques for detection including better radar, longer range sonar, and more effective electronic intercept equipment. (2) *Classification*—We spend too much time classifying a target, and we need better methods to classify a contact as sub or nonsub—we should be able to do this in seconds instead of minutes or hours. (3) *Tracking*—Our equipment for tracking at high speed must be improved, and we must be able to track the target continuously. (4) *Destruction* —Finally, we need improvements in the speed and certainty of a kill.

For all of these we need improved communications for coordinating the team play which is so vital to ASW. This includes communications between ships, aircraft, and submarines. All these areas are wide open for new ideas.

Within the depths of the oceans lie many of the answers to these problems. Our oceanographic programs are directed toward the exploration of the vast hidden world beneath the surface of the seas. The answers to many of our problems in ASW lie here.

ABOUT a hundred years ago, one of our greatest Americans, Abraham Lincoln, in his Gettysburg address prayed "That this government of the people, by the people, and for the people shall not perish from the earth." We hope that American industrialists will consider antisubmarine warfare as vital to the security of this Nation and the free world and will give us their ideas for quicker and better solutions so that in case of any major war this Nation shall not perish from the earth.



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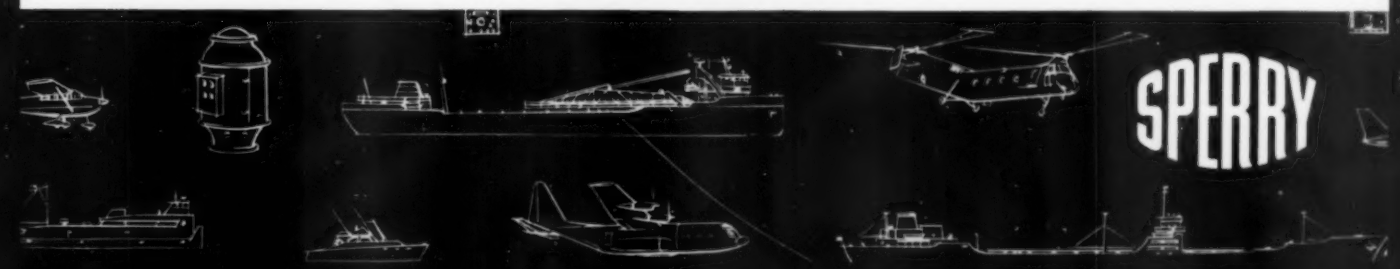

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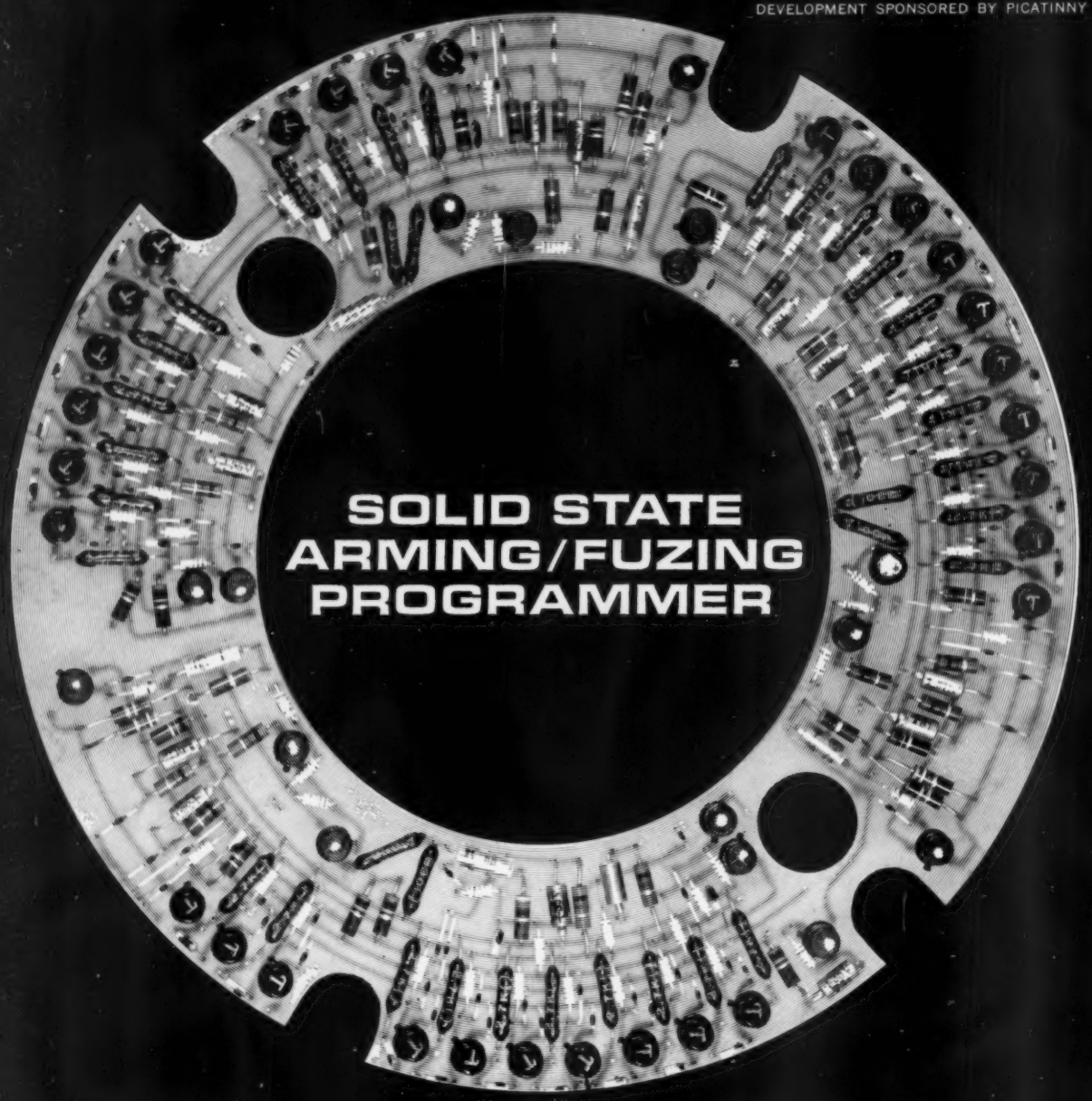

All-electronic digital timing programmer controls atomic warheads with better than 0.1% accuracy under extreme environmental conditions

Developed in cooperation with the U. S. Army Tactical Atomic Warhead Laboratory at Picatinny Arsenal under a program of supporting research, this new digital timing programmer represents a significant advance in the state-of-the-art for arming/fuzing devices. For this particular application, the programmer includes two identical channels, each with a 4-stage, adjustable timing program *accurate to within 0.1%* under any combination of temperature (—65°F to +165°F), voltage (26.5 ±5.5 Vdc), vibration (50 g's/2000 cps), shock and acceleration (100 g's). This new standard of accuracy under rugged environmental conditions is, however, practically meaningless until it is combined with another, equally important consideration always present in modern atomic weapon systems — *reliability*. The programmer's proven solid state design, *without any moving parts*, together with the unique packaging methods utilized, potentially offers a safety-reliability level substantially higher than previously attainable.

This arming/fuzing device is only one specific application of Tempo's exclusive solid state digital programmer design. Circuit versatility permits an almost infinite number of applications. Number of functions to be controlled is limited only by the allowable physical size of the device. Timing increments can be as close as 10 microseconds. Functions can be fixed or variable in time from the application of power or from a control signal. Two basic characteristics, however, are present in all versions; a high degree of accuracy and maximum reliability — both guaranteed under a wide range of extreme environmental conditions. If these characteristics are vital requirements of *your* timing programmer, Tempo can help you.

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	Page
Aerojet-General Corporation	Cover II
Aeronutronic, A Division of Ford Motor Company	18
Aircraft Armaments, Inc.	81
Aluminum Company of America	30
Amcel Propulsion Inc., A Subsidiary of Celanese Corporation of America	121
American Machine & Foundry Company, Government Products Group	137
American Systems, Inc.	86
Arma Division, American Bosch Arma Corporation	131
Avco Corporation	76
Bell Aerosystems Company, Avionics Division	Cover IV
Bell Telephone Laboratories, Inc.	160
Bendix Corporation, Scintilla Division	87
Bourns, Inc.	111
Budd Company	85
Bundy Tubing Company	93
Burroughs Corporation	123
Carlstrom Pressed Metal Company	14
Carpenter Steel Company, Alloy Tube Division	96
Caterpillar Tractor Co.	28
Cleveland Container Company	77
Continental Aviation & Engineering Corporation	27
Curtiss-Wright Corporation, Princeton Division	92, 122
Defense Systems Division, GMC	79
Detroit Diesel Engine Division, GMC	135
Douglas Aircraft Company	11
Dow Metal Products Company, Division of Dow Chemical Company	26, 82
Du Pont de Nemours & Company, E. I.	88, 89
Edgerton, Germeshausen & Grier, Inc.	113
Fairchild Camera & Instrument Corporation, Defense Products Division	7
Food Machinery and Chemical Corporation	119
Fuller Brush Company	134
FXR a division of Amphenol-Borg Electronics Corporation	14
Garrett Corporation	24
General Precision, Inc.	106
Government Products Group, American Machine & Foundry Company	137
Hamilton Standard Division, United Aircraft Corporation	94
Hercules Powder Company	8
Hoffman Electronics Corporation, Military Products Division	84
Hunter Manufacturing Company	29
Impact-O-Graph Corporation	139
Kaiser Aluminum & Chemical Corporation	25
Kearfott Division, General Precision, Inc.	80
Kohler Company	134
Kollmorgen Corporation	91
Lepel High Frequency Laboratories, Inc.	124
LeTourneau-Westinghouse Company	105
Librascope Division, General Precision, Inc.	10
Mahon Company, R. C.	13
Mason & Hanger-Silas Mason Company	138
Motorola, Inc., Military Electronics Division	12
Mueller Brass Company	15, 16
National Tube Division, U. S. Steel Corporation	14
Northern Ordnance, Incorporated	139
Northwestern Ordnance Parts Division, NAPCO Industries, Inc.	103
Nortronics, A Division of Northrop Corporation	117
Oakite Products, Inc.	17
Ordnance Associates, Inc.	127
Parsons Company, Ralph M.	Cover III
Philco Corporation, Government and Industrial Group	5
Pyrofuze Corporation, An Affiliate of Sigmund Cohn Corporation	90
Radio Corporation of America	109
Radioplane, A Division of Northrop Corporation	101
Rockwell-Standard Corporation, Transmission and Axle Division	23
Sheffield Corporation, Subsidiary of Bendix Corporation	22
Sperry	157
Sperry Electronic Tube Division, Sperry Rand Corporation	20
Tempo Instrument Incorporated	158
Texas Instruments Incorporated	99
Thiokol Chemical Corporation	6
United States Steel Corporation	114
Vitro Laboratories, A Division of Vitro Corporation of America	140
White Diesel Engine Division, White Motor Company	32

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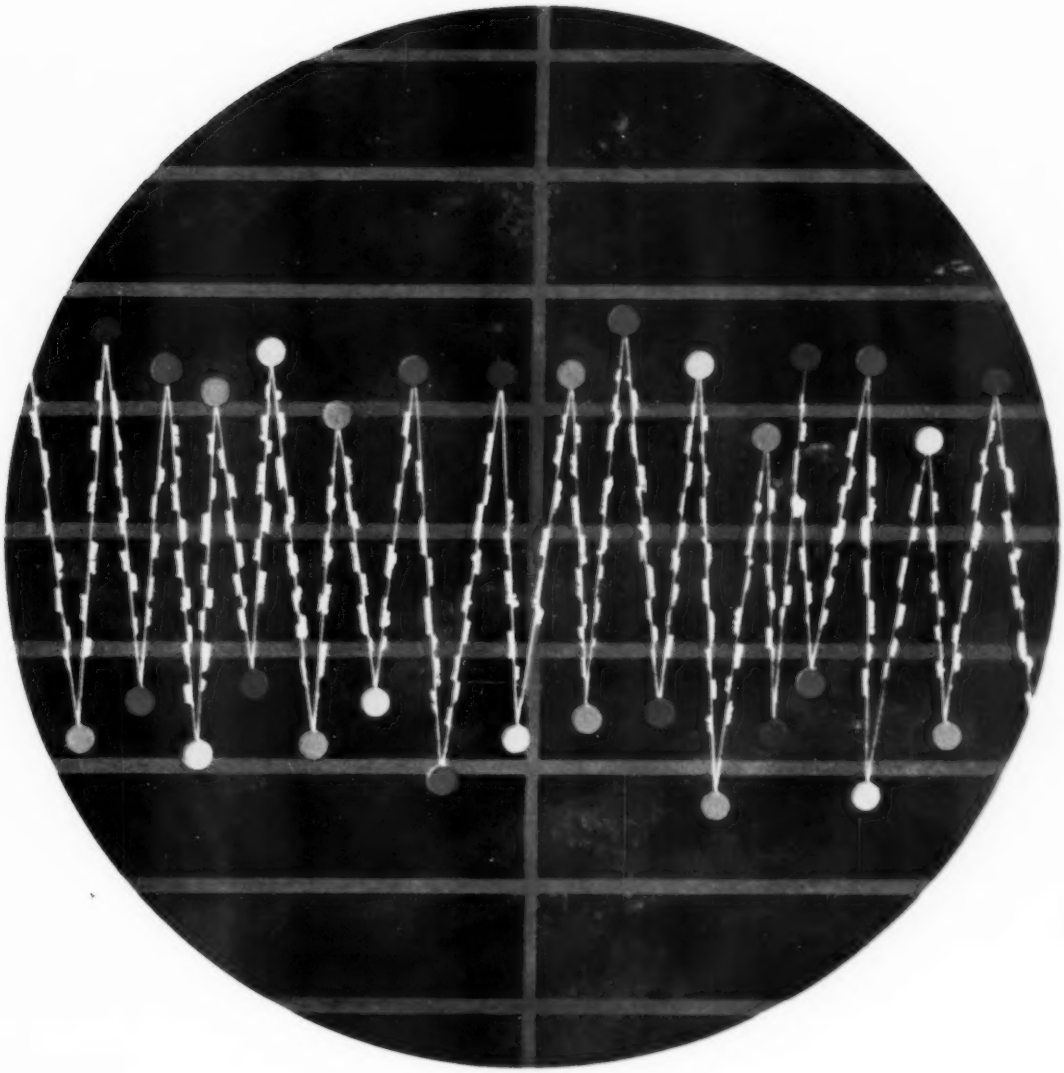

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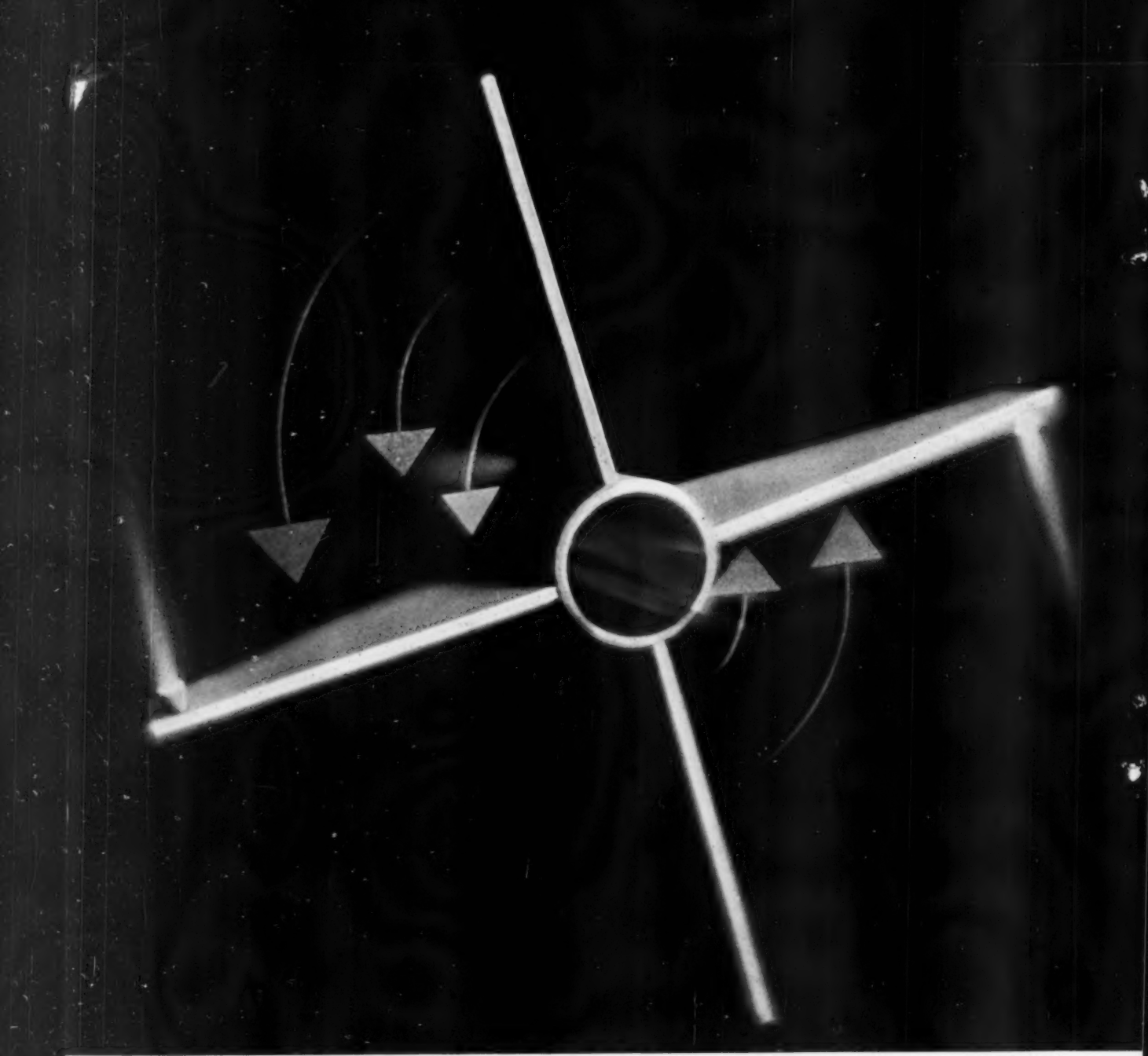

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